TOPICS OF THE MONTH

Still more chemical engineers needed

DEMAND for chemical engineers is increasing. Today they are needed not only in the chemical and allied industries, oil refining and petrochemicals, but in the processing of food, the processing of coal, in gas and electricity, in atomic energy, in extractive metallurgy, in antibiotics and many other industries. This was stressed recently by Sir Harold Hartley, past president of the Institution of Chemical Engineers, who pointed to the fact that the young chemical engineer now has a choice of alternative offers of employment at a high salary, often before the class of his degree is known—a convincing indication that the demand at present exceeds the supply.

Writing in the *Financial Times*, Sir Harold Hartley pointed out that recent statistics of the growth of the chemical group of industries emphasise the importance of the problem. Since 1948 the average rise in both output and productivity has been roughly twice as great as in manufacturing as a whole. Moreover, chemical engineering makes another significant contribution to Britain's balance of trade by the export of plant and of the 'know-how' of chemical processes. There is a growing trend in overseas countries to manufacture heavy chemicals, acids, alkalis and fertilisers near the point of use in order to avoid the cost of transport and foreign payments. Britain with her long experience in the development of chemical plant can play a great part in this field, but again it depends on an ample supply of well-trained chemical engineers to design, construct and commission the new plants that are required all over the world.

Sir Harold calculated that, at the present rate of expansion of the chemical industries and allowing for further demands for chemical engineers in other industries, the potential demand in ten years' time might easily rise to between 1,200 and 1,500. He indicated that a considerable shortage exists at the moment, for, taking all sources into account, the total intake in 1955 will probably lie between 300 and 400 as compared with a potential demand of 600.

He saw promise of substantial additions to the output of chemical engineers in the near future in the extension of chemical engineering departments in the universities, which offer increased facilities for post-graduate research. He concluded by suggesting means by which industry can help to produce the chemical engineers it needs. It can endow chairs and departments, as it has done at Birmingham and Cambridge; it can endow research; it can provide facilities for vacation works courses for chemical engineering students; and it can encourage young apprentices to take 'sandwich' courses at technical colleges and organise instruction for the students during the six-monthly periods spent at works.

Paying for progress

THE direction of scientific research and development in Britain has come in for a good deal of discussion in recent months and there have been some lively exchanges, in Parliament and elsewhere, concerning the type of organisation that is needed at the top. During debates on the Department of Scientific and Industrial Research Bill there have been criticisms of Government handling of research matters and comparisons have been made with research and development progress in the United States. During discussions of this subject the question of finance has been recognised as an important factor, but until now there have been no up-to-date figures available showing the amount of money spent on research and development in Britain.

The D.S.I.R. has recently been carrying out surveys aimed at estimating the British investment in research and technical development and, with these surveys still proceeding, preliminary estimates have been put out in a paper presented to the British Association on September 4 by Mr. E. Rudd of the Intelligence Division of the D.S.I.R. These estimates are subject to relatively large margins of error and may have to be revised when the surveys are finished, but they are believed to be correct as to the order of the amounts spent and offer interesting comparisons with similar estimates for the U.S.

It can be seen that Britain spends about £325 million on research and development (although the error here may be as high as £80 million), of which £185 million was spent in private industry, mostly by aircraft, electrical engineering and chemical firms. The expenditure by chemicals and allied trades (other than mineral oil refining) is estimated as £20 million.

In Government laboratories, the amount spent was £122 million (including £6.5 million for mining and industry and £30 $\pm$ £25 million for atomic energy). Nationalised industries probably spend about £4 million and a further £16 million can reasonably be assumed to have been spent by miscellaneous organisations such as research associations and universities.

It is also interesting to note that some 130,000 people are engaged in research and development in British industry (equivalent to 106,000 full-time workers or 1% of the total employees). Of these, 30,000 hold a degree, or equivalent qualification, in science or engineering. Only 100,000 of them spend all their time on research and development. The rest combine this with other kinds of work. Aircraft firms lead in the proportion of manpower employed on research or development (12%), followed by mineral oil refining (6%), electrical engineering (4%) and the chemical and allied industries (3%).

The latest similar figures available for the U.S.

refer to the year 1953, which makes comparison with Britain a little difficult. In that year American industry is estimated to have spent £1,320 million, taking the rate of exchange at \$2.8 = £1. The industries with the largest expenditures were the same as in Britain, electrical equipment, aircraft and chemicals, although their order of size is different. In America they spend half the total compared with three-quarters in Britain.

Comparison is easier using manpower figures. These indicate that industry in the U.S. employs about six times as many graduates on research and development as does industry in Britain. The proportion of graduates employed in industry as a whole is much higher than in Britain (0.9% compared with 0.26% of the labour force).

Per head of the population the United States spent £12 compared with £7 in Britain at current rates of exchange.

The estimated American expenditure in 1953 was 1.5% of the country's gross national product, compared with Britain's 2% in 1955. However, the American expenditure on national security research and development was \$1,800 million—34% of the total—compared with an expenditure by the British service departments, etc., of about £200 million to £210 million—over 60% of the total. The remaining civil expenditure was 1% of the American gross national product in 1953 and 0.7% of the British gross national product in 1955. As the American gross national product in 1953 was 2½ times as much per person as the British in 1955, it follows that American expenditure per head on civil research and development was more than three times that of Britain. Even at the 1948 exchange rate of \$4 to the pound, the American expenditure would still be more than twice the British.

Atomic energy in petroleum processing

GOOD possibilities for the use of atomic radiations in processing petroleum and its products have been reported from the United States, where the Standard Oil Co. of New Jersey has been conducting experiments with this in view. Preliminary data have been promising and, on a purely experimental basis, sample quantities of petrol and other oil products have been produced with the aid of gamma radiation.

Not the least of the attractions of this line of work is that it may become possible for oil refineries to operate without using the high temperatures that are now needed, though this is still in the realm of speculation. Considering that present temperatures average about 1,000°F. it can be seen that, if the use of atomic radiation makes it possible to conduct refining operations at lower temperatures, important savings of materials and reduction of other costs may become feasible.

The company has been studying the problem for nearly a year in a newly built radiation laboratory at Linden, New Jersey. Its studies have centred on the use of gamma radiation from a 1-ft.-long section of cobalt 60—a radioisotope of ordinary cobalt, energised by exposure to radiation from a nuclear reactor.

The company's research programme is now being expanded through an agreement with the Battelle Memorial Institute, the large private industrial research organisation of Columbus, Ohio. Nearing completion at the Institute is a 'swimming pool' type of nuclear research reactor, the major unit in what will be the United States' largest privately owned nuclear research centre.

The Standard Oil Co. of New Jersey will use the Battelle reactor for more extensive tests than have been possible at Linden.

Samples of oil materials, and possibly even miniature models of oil-refining units, will be immersed in the pool of water that surrounds the core of the 'swimming pool' reactor.

The Battelle reactor will give off several hundred times more radiation than the radioactive cobalt which has been used at the Linden laboratory.

Everybody wants stainless

STAINLESS steel is today an indispensable material of construction for the chemical engineer, but wide and still increasing application of this metal in other fields creates a good deal of competition for supplies. Thus, in the *Manchester Guardian* recently, Mr. C. E. Holmstrom, joint managing director of Firth-Vickers Stainless Steels Ltd., comments that the growth in the use of stainless steel in the last quarter of a century has been quite spectacular, production in the United Kingdom being now more than 130,000 ingot tons p.a. and, in the United States, over 1 million tons. Mr. Holmstrom points out that the one factor which is causing anxiety to the stainless-steel manufacturers in Britain is the acute shortage of nickel, aggravated by the U.S. Government's policy of stockpiling this valuable and strategic alloy. Alternative steels, containing a smaller percentage of nickel, with the addition of manganese, are rapidly being developed, and are finding an ever-increasing application.

In the 40-odd years since Brearley's invention in 1913, stainless steel has made a significant contribution to our modern civilisation and its use in domestic equipment alone has grown tremendously. But, as Mr. Holmstrom says, probably the greatest single factor in the ever-growing demand for stainless steel has been the development and growth of the chemical industry. The first large industrial application of this nature was for the production of synthetic nitrogen products, and many thousands of tons of stainless steel are today in use in the big I.C.I. plant at Billingham. Other industries were quick to follow suit and stainless steels are now used in large quantities in the construction of dairy plant, food manufacturing machinery, dyeing machines, brewery equipment and a host of other applications. In a chemical age, practically every new invention calls for the use of stainless steel in some form or another: the new drugs penicillin and aureomycin, and the new synthetic fibres, are recent examples. Lastly, stainless steel is now playing an important part in the production of atomic energy, for which purpose large quantities are now being used.

Synthetic rubber production comes to Britain

A SYMPOSIUM which was held recently at the Fulmer Hall applicational research laboratories of Monsanto Chemicals Ltd. indicated the increasing rapidly mounting interest in the production of synthetic rubber in Britain. Two grades of Monsanto's new high-styrene resin were exhibited to representatives of the footwear and rubber industries and it was announced that *Tred* 50 and *Tred* 85, hitherto available on pilot-plant scale, would shortly be in production at the company's new plant at Newport.

These resins are copolymers of styrene and butadiene and, although high-styrene resins have formerly been available from the U.S., Canada and Germany, their impending large-scale production in the United Kingdom marks a new trend in petrochemical activities. Styrene has been manufactured for some years by Forth Chemicals Ltd., at Grangemouth, while butadiene is expected to be available soon as an indigenous product of the British petroleum refining industry.

Monsanto express a belief that *Tred* will prove to be an important basic ingredient for resin rubber, semi-expanded, and microcellular soling and development quantities of the material have been distributed to potential users for test purposes.

Further evidence of the increased activity in the synthetic rubber field in Britain comes from Imperial Chemical Industries Ltd., whose Plastics Division has recently introduced a range of copolymers of butadiene with a variety of other monomers such as styrene, methyl methacrylate and acrylonitrile, making their appearance in Britain for the first time. A new plant to manufacture 10,000 tons p.a. of *Butakon* copolymers of various types is expected to be in operation at the Wilton site in north Yorkshire by the end of the year.

The large-scale manufacture of synthetic rubber by I.C.I. and Monsanto, and by Dunlop Rubber Co., whose big experimental plant at Fort Dunlop is expected to be in operation soon, will see the firm establishment of this industry in the United Kingdom and a lessening of dependence on the imported product.

Comical Engineering Situations

"SOMETIMES I WONDER IF WILKINSON HAS QUITE THE RIGHT ATTITUDE TOWARDS SCIENTIFIC RESEARCH WORK"

Work study and process instruments

HOW work study can assist in the installation, operation and maintenance of instruments, as well as in their design and manufacture, has been described by Mr. Christopher J. Pratt, M.I.CHEM.E., in our associate journal *Manufacturing Chemist* for September. He points out that, although the layout of large instrument installations as found on process plants and steam boilers is sometimes made on a basis of process flow or grouped according to particular plant sections or process variables, work-study principles may reveal that arrangements on these principles are conducive to fatigue and error. Some organisations have departed from a wide array of meters and controllers of different shapes and sizes and have developed miniature, standard-sized equipment which can be installed in a console or at eye level for easy reading.

Mr. Pratt, who was lately work-study officer of the Association of British Chemical Manufacturers, states that increasing numbers of process plants already using work measurement as a means of controlling production costs are extending this principle to maintenance and repair work of all types. In cases where instrument upkeep and repair costs are also available in terms of standard costs based upon work measurement, a valuable source of information exists concerning the finer points of design and construction. Such information enables accurate comparisons to be made between different types and makes of instruments which, if made available to the manufacturers through appropriate channels, could guide them in producing equipment still more reliable in operation and less costly to maintain.

Similarly, operating costs for all types of instruments and in different locations can be compared accurately if based upon standard work-measurement data. Such information, besides guiding the user as to the best type and make of equipment to buy, could also help to establish better design and construction, if made available to manufacturers through organised channels.

Since it is cheaper to use a method study chart and an india-rubber in the design stage than it is to make extensive alterations to equipment when in operation, it is suggested that work-study principles be applied early in the design of a proposed instrument installation.

This can be effected either by including a work-study specialist in discussions concerning the design or, in some cases, by the designers attending from time to time short courses which teach the principles and applications of method study and work measurement.

Deodorising vegetable oils

SOME chemical engineering skill of a high order goes into the refining of vegetable oils these days, and a good example of the present-day high standards of economy and efficiency is provided by the deodorising equipment installed at the Manchester refinery of Southern Oils Ltd., where raw vegetable oils are converted into edible oil suitable for the manufacture of margarine and cooking fat. Complete deodorisation is necessary with all oils to be used for edible purposes. The process is one of steam distillation in a closed vessel under a high degree of vacuum, and the object is the removal of volatile constituents with distinctive odour and taste.

There are three deodorisers, made by Rose, Downs & Thompson Ltd., of Hull, to the designs of the Girdler Corporation, of America. They are fully automatic and of a semi-continuous type which offers advantages over both batch and continuous equipment. Each deodoriser consists of a cylindrical mild-steel shell about 28 ft. tall and 9 ft. in diameter. Five trays are fitted inside the shell, one above the other, the inside of the shell being maintained at a vacuum of about 6 mm. of mercury.

The whole sequence of operations is controlled automatically, and as each tray discharges to the one below it is refilled from the one above, so that there is a continuous progression of oil through the deodoriser. As the basis of the operation is batch treatment, it is possible for different types of oil to be treated in successive cycles without intermixing.

The equipment and processes used for this purpose have been described in a recent technical bulletin of Henry Wiggin & Co. Ltd., which points out that the choice of materials for the construction of plant handling raw vegetable oil is important. Corrosive attack, which can arise from the fatty acids and other impurities present, is aggravated by the high temperatures at which the process is operated. Certain metals are unsuitable because they have a catalytic effect on the deterioration on storage of the oil, producing undesirable reversion of taste and colour. The formation of toxic metal compounds must, of course, be prevented. Nickel has been used extensively in the deodorisers at the Southern Oil Co.'s refinery, and hot oil is in contact with only nickel or stainless steel while in the deodoriser.

Coal, iron and chemicals

WITH his installation this month as the 321st Master of the Ancient Company of Cutlers (as reported in our 'Personal Paragraphs') Sir Peter Roberts is following the example of his forbears. As chairman of Newton, Chambers & Co. Ltd., he is also following in the family tradition, and this firm of ironfounders, engineers and chemical manufacturers can now look back on 160-odd years of progress since the business was established in 1793.

In those early days ironstone was mined in the area and the firm was continually engaged in the smelting and casting of iron for a period of 147 years. Coal mining also comprised a major interest for the company and, at the time of nationalisation in 1947, it was operating four collieries and one of the largest coal distillation plants in the country. In their Thorncliffe ironworks, the company were pioneers in the manufacture of gasworks plant and continue to carry out important contracts for the gas industry, supplying plants of all types and sizes including giant gasholders.

It seems a far cry from all this to the manufacture of *Izal*, parent of a large family of sanitary and hygienic products including household and industrially used disinfectants and medicated paper, now being produced in a modern and highly mechanised factory. The chemicals branch of Newton Chambers originated in the scientific processing of the oil products of coal carbonisation.

Another thriving division of the Newton Chambers organisation today is the Lithcote Division, supplying corrosion-resistant linings for vessels, pipes, etc., in the chemical, food and other industries.

International patents conference

AN international diplomatic conference will be held in Lisbon in the autumn of 1957 to revise the International Convention for the Protection of Industrial Property. The convention covers patents, trade marks, designs, trade names and protection against unfair competition, and is now in force between 52 countries.

A preliminary list of proposed revisions has been drawn up by the International Bureau at Berne, the administrative body for the Convention. It is based largely on amendments proposed by the International Chamber of Commerce and the International Association for the Protection of Industrial Property (A.I.P.P.I.).

At its biennial international congress in Washington in May the A.I.P.P.I. proposed the following revisions to the convention.

The text of the convention is to be recast completely in accordance with the drafts proposed by the American group and by the chairman of the I.C.C. Commission on Industrial Property.

Patents may not be refused or invalidated because the subject matter cannot be used or marked under the laws of regulations in a particular country, unless the prohibition relates to public order or morals.

The nature of a product for which a trade mark is used cannot prevent the registration or renewal of such mark and the exclusive right of the owner cannot be suppressed or limited when the sale of the product is lawful.

Service trade marks may be registered and protected in every country and must be treated the same as ordinary trade marks.

Failure to work a patent in a country shall not be deemed an abuse of the monopoly granted by the patent justifying restrictive measures against the patentee.

The convention should be revised to prohibit all false indications of geographical origin and all false descriptions relating to the nature, composition and quality of the products.

Corrosion and Construction Problems of SULPHURIC ACID PLANT

By G. C. Lowrison, B.SC., A.M.I.CHEM.E., and F. Heppenstall

In the following the methods and materials of construction used in the manufacture of sulphuric acid are described, from the handling and storage of raw materials right through to the acid concentration stage. There is a wealth of information in this article, all based on the authors' own experience with the sulphuric acid manufacturing division of Fisons Ltd. at Immingham, near Grimsby.

IN the manufacture of sulphuric acid, the production of sulphur dioxide, its oxidation to sulphur trioxide and subsequent absorption in sulphuric acid are stages common to all methods, and most attention will be given to the materials of construction for these processes. The steps in each of the manufacturing processes may be grouped under the following heads, which will be dealt with in turn:

(*a*) Handling and storage of raw materials.
(*b*) Preparation of raw materials for burning.
(*c*) Burning.
(*d*) Transport of gas.
(*e*) Gas cleaning.
(*f*) Conversion.
(*g*) Gas cooling.
(*h*) Absorption.
(*i*) Acid cooling.
(*j*) Storage and transport of acid.
(*k*) Concentration of acid.

(a) Handling and storage of raw materials

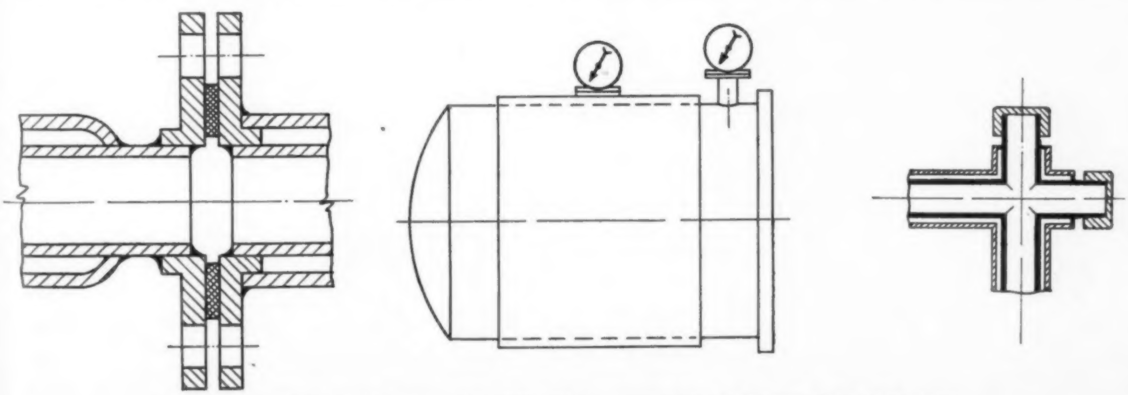
The principal raw materials for the manufacture of sulphuric acid are sulphur, pyrites, sulphides of zinc, copper and lead, spent oxide and anhydrite. No special materials of construction are required for handling equipment or storage buildings for any of these with the exception that, with sulphur, care has to be taken to prevent the accumulation of charges of static electricity and the formation of enclosed pockets of dust. Elevators are to be avoided, but, if essential, slow-moving types should be employed with buckets mounted on endless rubber belts and with elevator casings of sheet rubber. Other raw materials such as hydrogen sulphide, pickle liquor and sludge acids are by-products of particular industries and their mode of handling will depend upon the conditions under which they are produced.

(b) Preparation of raw materials for burning

(i) Sulphur. Sulphur is usually first melted in concrete, brick or mild-steel vessels heated by means of mild-steel coils, mild steel and cast iron being unaffected if totally immersed in molten sulphur. All ancillary equipment such as pumps and pipelines and agitators are manufactured in mild steel or cast iron. The vapours from molten sulphur are acidic and will condense on cool surfaces such as the top covers and, under these conditions, mild steel is readily attacked whilst aluminium is unaffected. Covers are therefore usually constructed of aluminium-lined steel, the aluminium sheet being fixed to the mild steel by aluminium bolts or rivets. In some quarters, aluminium steam coils have been advocated, presumably to guard against condensation corrosion and also to give better heat transfer.

Most commercial sulphur comes from Texas and contains about 0.5% non-volatile matter. On plants burning large quantities, the residue is sufficient to cause blockages in subsequent stages of the process and it is modern practice to filter out this residue on cast-iron-bodied, stainless-steel, gauzed leaf filters; we find stainless-steel gauze suffers more mechanical damage than chemical attack, so that mild-steel gauze has an equal life, particularly if the acidity of the sulphur is controlled by the addition of lime.

The filtering of sulphur presents some difficulties, not so much from a chemical point of view as from the physical one of keeping the sulphur molten. We have found that there is a practice among filter manufacturers



Figs. 1—3. Methods of overcoming difficulties encountered in the filtration of sulphur.

not to protect all of the equipment with steam jacketing, for example: (*a*) on pipelines, to finish the jacketing short of the flanges at joints; or (*b*) to fit instruments so that they rise out of the jacketing; or (*c*) at bends, not to provide complete jacketing and facilities to cope with the inevitable occasional blockage. We have overcome all these shortcomings in the ways shown in Figs. 1 to 3.

The diaphragm of the pressure gauge was originally constructed in 13% chromium stainless steel, but this failed after one month's service; this was remedied by the use of a protective sheet of *Fluon* fitted on the pressure side of the diaphragm.

A useful coupling for a flexible steam pipeline on a sulphur filter is the Gullick coupling shown in Fig. 4.

(ii) **Pyrites.** Pyrites was not usually given any treatment prior to burning because it was received in this country from the mines already screened to size. Originally, even for flash roasting, previous preparation was not necessary because the process was devised by Freeman to utilise waste pyrites concentrates separated from richer minerals by flotation, but the discovery that this process led to higher gas temperatures, with the consequent potentiality of by-product steam, induced acid manufacturers specially to grind the pyrites so that it could be utilised in this process. The grinding is carried out in Hardinge-type ball mills with manganese steel linings.

The preparation of the sulphides of zinc, copper and lead, is to suit the metallurgical process as that of anhydrite is to suit the cement process, and the equipment used is incidental to the manufacture of sulphuric acid. Spent oxide is not usually given any special preparation except perhaps coarse disintegration.

(c) Burning

(i) **Sulphur.** The materials of construction for a furnace burning sulphur vary with the type of furnace. There are those types in which combustion is integral with burning where the horizontal or vertical mild-steel shell is lined with insulating brick protected by firebrick. The firebrick is of the typical composition 42% alumina, 52% silica, which will withstand a working temperature of about 1,500°C. It is bonded together with a firebrick mortar consisting of finely ground previously fired firebrick (grog), some plastic clay, a little water-glass and enough water to make into a paste. This is backed with a fireclay insulating brick which is approximately of

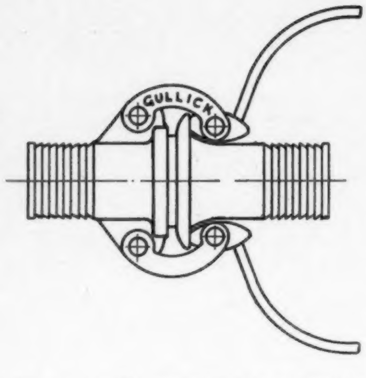


Fig. 4. Useful coupling for a flexible steam pipe.

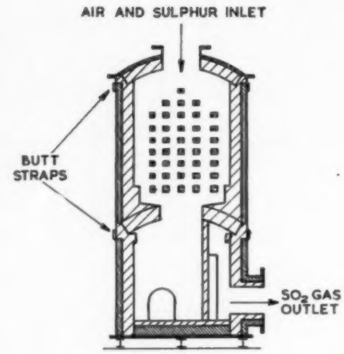


Fig. 5. Sulphur burner.

the same composition as the refractory brick and differs from it only in that, prior to firing, it had some combustible substance such as sawdust added to it so that when it was fired it became porous.

If the burner contains an arch, the thrust from this is borne by a butt strap around the shell, and expansion is accommodated by a packing of asbestos wool between the circumferential bricks and the steel shell (Fig. 5).

For the rotary type of burner usually specified for small rates of burning, brick lining is not necessary, because combustion takes place in a separate chamber from burning. The combustion chamber is constructed in insulating brick protected by firebrick.

(ii) **Pyrites.** Pyrites is burned in Herreshoff shelf burners, rotary kilns and flash roasters. The shelf burner is usually constructed in mild steel with brick lining, though small ones are often of all-brick construction, with steel thrust bands at each hearth level. The rakes are usually made in cast iron, although occasionally they are made in 13% chrome steel. The vertical iron shaft is sometimes protected with masonry.

The rotary burner has a mild-steel shell, firebrick-lined, with chrome-steel lifters. The flash roaster is of mild steel lined with firebrick.

(iii) **Spent oxide.** The only specially designed burner known to us for spent oxide which produces material suitable for re-use as an absorber for sulphur is the Flixborough furnace, which is a rotary, horizontal, brick-lined, mild-steel shell with a 17% chromium-steel combustion tube (Fig. 6).

(d) Transport of gas

Ducting for dry gas below 500°C. may be made of mild-steel-welded construction throughout. If the temperature is higher, it is necessary to line with firebrick. Accommodation for expansion in the mild-steel ducting is usually made by incorporating at intervals in the length an expansion joint. This is made by welding a flange to each of the two sections and joining the flanges through an annular distance piece and welding at the periphery (Fig. 7). If the gas is below its dewpoint then the ducting should be constructed in lead. It is usual to use about 20 lb. of lead and to support the ducting with mild-steel straps

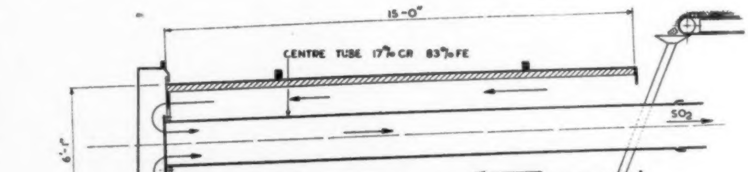


Fig. 6. 'Flixborough' rotary spent oxide burner.

supported by bars suspended from brackets; sometimes the straps carry a horizontal supporting bar under the ducting. The ducting is fabricated from single sheets, shaped round a wooden former and joined by a single weld, except in the case of bends, when it is usual to make two semicircular sections shaped on the former which, of course, has to be removed before welding the two pieces together.

Blowers feeding air to the system or pumping SO_2 are of two types: the centrifugal and the positive-displacement types. For air or dry gas, the centrifugal pump is usually constructed with impeller in welded 3% nickel steel and the casing in cast iron. The positive-displacement or Roots blower has cast-iron casing and lobes; owing to corrosion, the slip between the lobes gradually increases and this is compensated by the use of a variable-speed motor. The use of cast iron containing 2% copper is said to prolong the life of the impellers. If the gas is wet—and this would only apply in the nitration process—the only type used is the centrifugal blower constructed with a lead casing and cast lead antimony (12% Sb) impeller.

Valves in the gas system are preferably of the butterfly type, gate valves being most unreliable, since they tend to seize up. The butterfly valve can be firebrick-lined. Fig. 8 indicates the method of brick-lining the valve.

Waste-heat boilers for the larger plants are usually of the water-tube design, the solid-drawn mild-steel tubes being protected against abrasion by cast-iron sleeves or fins shrunk on to the mild steel. The shell is usually of welded mild steel insulated with a layer of slag wool covered with firebrick.

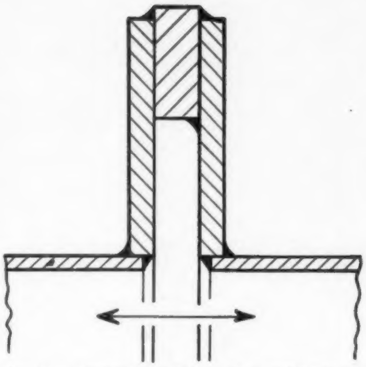


Fig. 7. Expansion joint for mild-steel ducting.

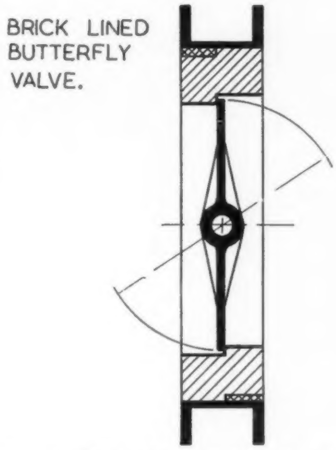


Fig. 8. Method of brick lining valves in the gas system.

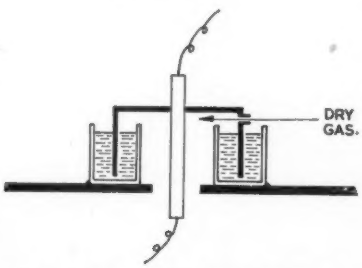


Fig. 9. Oil seals with dry gas bleed for H.T. leads to wet electrostatic precipitators.

(e) Gas cleaning

The design of electrostatic precipitators for gas cleaning depends upon whether they are intended for wet or dry gas. If the gas is dry the chamber can be constructed in brick, concrete or mild steel, brick-lined. The discharge electrodes can be made in mild-steel wire or preferably 18-8 stainless if above 500°C., suitably weighted to tension the wires and of as small a diameter as possible to obtain greatest electrical density, 2-mm. wires being proved to be the smallest practicable. The receiving electrodes are of mild-steel sheet suitably strengthened to prevent buckling. The power supply to the electrodes is insulated with fused-quartz sleeves passing through the walls of the chamber. If the gas is wet and below its dewpoint, then the chamber is constructed in lead suitably supported externally in a mild-steel frame. The discharge electrodes are of lead-coated mild steel, or sometimes of copper wire. The receiving electrodes are of sheet lead. The power supply is insulated from the chamber walls by means of an oil seal (Fig. 9), and it is usual to bleed in dry gas to prevent the accumulation of wet gas in stagnant places.

On sulphur-burning plants the gases are cleaned by passing through a quartz bed supported on a cast-iron grid contained in a mild-steel shell. Quartz is preferable to crushed silica brick, which spalls and causes blockages.

Cyclones are exclusively used for gas above the dewpoint and are made in mild steel.

The function of a Peabody scrubber is to wet and scrub the sulphur dioxide gas, and consequently the materials of construction are those which apply to wet gases and dilute acid. The tower is usually constructed in a mild-steel shell (say $\frac{3}{8}$ in.), lined with 10 lb. of lead and covered with acid-resisting brick. The entrainment separator containing impingement plates is constructed in 18-8 stainless steel containing 3% molybdenum stabilised with columbium (without which it is quite unsuitable) and the stripping column at the base of the tower is constructed in the same material, as are all internal fittings. The air fan is made in butyl rubber-lined mild steel (Fig. 10).

The wet-gas scrubber or Glover tower is usually constructed in lead on a steel framework, packed with acid-resisting earthenware rings and—especially in the case of gases from pyrites burners—the rings must be evenly placed to avoid pockets where solid can accumulate and block the tower. Recently, reaction towers have been constructed entirely in acid-resisting brick except that a membrane of polythene has been interposed between inner brick lining and outer brick shell. In Italy the whole tower has been constructed in polythene supported with wooden staves and steel bands, apparently with entire success.

Coke scrubbers usually consist of lead boxes protected with acid-resisting earthenware tiles and filled with graded coke.

(f) Conversion

Because in the contact process the gases are always dry in the converter, there are no particular difficulties with materials of construction, except that the cast-iron catalyst grids and mild-steel plates, especially after the first pass, tend to flake, principally because of the high temperature; to prevent this, spluttering with chromium and/or spraying with aluminium have been tried.

(g) Gas cooling

In the contact process, cooling of the gas prior to absorption is effected by waste-heat boilers previously described. After the converter, the gas

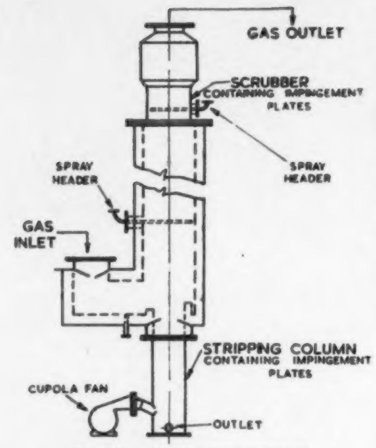


Fig. 10. Peabody scrubber.

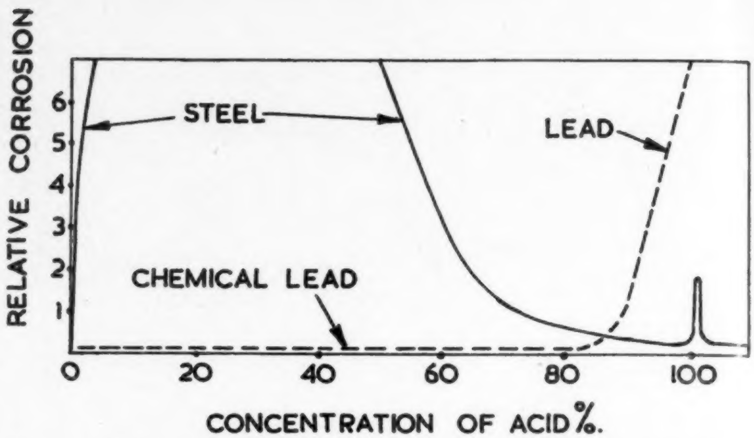


Fig. 11. Corrosion of steel and chemical lead at atmospheric temperatures.

is cooled either by preheating the boiler feed water or the combustion air. In either case, the materials of construction are similar to those previously described, except that it is advisable to line the base of the vessel with acid-resisting brick as a protection against possible oleum formation.

(h) Absorption

At the absorption stage we meet for the first time the problem of handling acid.

Metals. In the above plant description it will have become very evident that lead and mild steel are complementary to one another and that neither is suitable for the whole range of concentrations of sulphuric acid, as is clearly shown for one particular temperature in the diagram (Fig. 11).

Fontana[1] states that there is a sudden leap in corrosion at 101%, and that an 18-8 stainless steel is the best answer for this particular concentration.

Close-ground pearlitic cast iron (2.75% C, 1.5% Si) is superior to mild steel for hot concentrated acids (85 to 99%), although it is not recommended for oleum because the SO_3 attacks the graphite particles, causing them to swell and crack the parts.

Owing to its limitations at concentrations above 80%, lead has found its most common use in the nitration process. Chemical lead may be divided into four types according to the British Standard Specification STA 7 drawn up in 1942:

Chemical lead L.1 (*B.S.S.* 334, *type A*, *purity* 99.99%). This type should be used where the highest possible corrosion resistance is required and where mechanical strength is not of prime importance.

Chemical lead L.2. This is similar to L.1 but has slightly higher nickel content and improved mechanical properties, due to smaller grain size, with a somewhat lower corrosion resistance.

Chemical lead L.3 (*B.S.S.* 334, *type B*). This material contains 0.07% Cu. This gives it a finer grain and consequently improved resistance to temperature fluctuation and vibration.

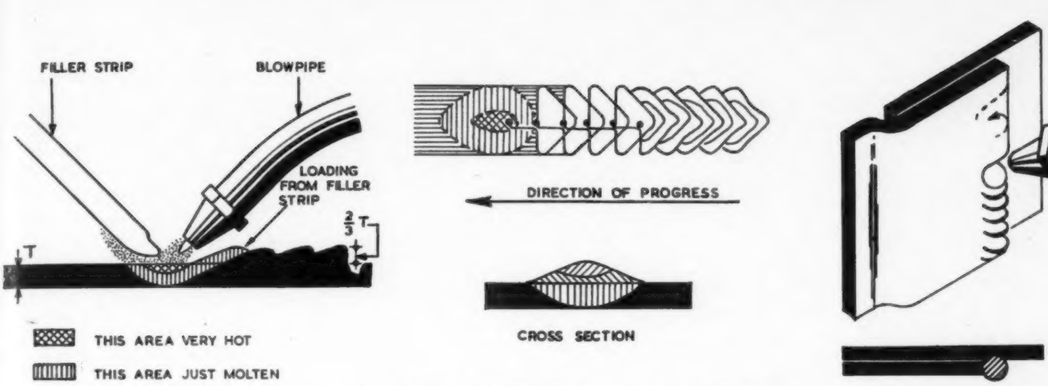
Chemical lead L.4. This lead contains, in addition to 0.07% copper, 0.045% tellurium. The presence of tellurium increases its tensile strength and resistance to grain growth under conditions of vibration.

Lead has physical limitations as a constructional material and care must be taken in choosing the correct grade for the particular piece of plant or equipment. Due to its soft nature, lead is easily eroded and, for certain equipment, it is necessary to alloy it with antimony to increase the hardness, but this results in lower corrosion resistance and a lower melting point and is not recommended for acid concentration in excess of 70% or for use at temperatures in excess of 120°C. The softness of lead is particularly important in the composition of valves, bends in pipelines and pump casings and impellers. In these instances it is usual to alloy with 10 to 12% antimony. For large ductings where the erosion is much less but mechanical strength is required as well as maintaining as far as possible chemical resistance, 2 to 4% antimony is used.

It might be interesting at this stage to make some reference to the welding of lead or, as it is commonly known, lead burning. This consists of joining the lead together by fusion using a mixture of oxygen and combustible gas. It is important to obtain the correct gas mixture; an excess of oxygen will result in an oxidising flame; too much combustible gas will leave a deposit of carbon which will prevent correct fusion. When burning together butt joints a filler strip is used and this must be of the same composition as the lead being welded. Overlapped joints can be made without a filler strip. The welding of lead causes changes in the crystalline structure, particularly in the case of L.1

Table 1. Sulphuric-acid-Resistant Alloys (in order of Nickel content)

	Ni %	*Fe* %	*Cr* %	*Mo* %	*Cu* %	*Si* %	*C* %
Nickel	100						
Langalloy 6R	85				3	10	
Inconel	76	7.5	15.5		0.2	0.25	
Nimf	70	10	20				
Monel	67	1.4			30		
Corronel B	66	6		28			
Chlorimet 2 / *Langalloy* 4R ...	62	3		32			0.1
Chlorimet 3 / *Langalloy* 5R ...	60	3	18	18			0.07
R55-*Langalloy* 7R ...	52	8	23	4	6	4	0.2 to 0.3
Durimet 20	29	51	19	3	4	1	0.07
Carpenter 20 CB ...	25	48	20	2	3	1	0.07
Worthite	24	48	20	3	1.75	3.25	0.07
Durimet T	22	54	19	3	1	1	0.07
Ni-Resist	15.5	71	2		6.5		



Figs. 12—14. Welding of lead or lead burning.

type, and this difficulty can be a source of weakness. Improvement in homogeneity can be obtained by hammering the weld, the copper-bearing leads having a finer grain structure which is retained during welding and results in a stronger weld (Figs. 12 to 14).[2]

A process known as homogeneous lead lining is sometimes employed in which are combined the corrosion-resistant properties of lead with the mechanical strength of steel. The thickness of lead can vary to suit weight considerations. The surface of the steel is first tinned with solder having a high tin content and then sticks of lead are melted so as to cover progressively the whole of the required area. The initial cost of homogeneous lining is quite high, but it is sometimes worth while where high mechanical strength is required.

Attempts have been made to alloy metals so that they have a property of universal corrosion resistance to sulphuric acid and at the same time to have the requisite mechanical properties. In this connection, the nickel alloys figure most prominently, and the best known are arranged in order of their nickel content in Table 1.

Two known substances are reasonably stable in all concentrations of sulphuric acid up to its boiling point: silicon iron and tantalum. Silicon iron (14.5% Si) suffers from the disadvantage of poor mechanical strength and resistance to thermal shock; tantalum is most expensive and is usually used in sheets spot welded to mild steel.

Fig. 15[3] shows the iso- corrosion lines for lead, mild steel, *Chlorimet* 2, *Chlorimet* 3, *Durimet* 20 and *Duriron* (silicon iron), each plotted to show a penetration rate of 0.020 in./yr. From these graphs it is seen how very sensitive to temperature is mild steel and that, if temperatures much above 75°F. are realised, the corrosion rate is quite appreciable, at all events up to a concentration of about 95%, and that mild steel only becomes really satisfactory above atmospheric temperature when it enters the oleum stage. A comparison is also made for the penetration rate of 0.005 in./yr. (Fig. 16) and, in it, this sensitivity to temperature is emphasised. The exceptionally good corrosion-resisting properties of silicon iron are illustrated.

Various attempts have been made to inhibit the corrosion of iron, which is of course, the commonest and simplest material of construction, by adding to the acid certain substances. These have notably been chromates and arsenic, *e.g.*, Berwick, *Chemistry & Industry*, April 25, 1953, states that one part per thousand of dichromate passivates 18-8 chromium nickel steels, and Wachter, Treseder and Weber (*Corrosion*, 1947, **3**, 406) have shown that 0.15% As_2O_3 in 71% acid may reduce the corrosion rate to less than 3% of that in the uninhibited acid.

Siliceous substances. Fused clays and glasses are resistant to sulphuric acid and oleum at all concentrations, but they suffer from the defect that they are very susceptible to thermal and mechanical shock. Aluminous cement is also resistant to dilute sulphuric acid.

In at least one plant, glass (*Pyrex*, borosilicate) piping has been used for acid coolers, acid passing inside and water passing over the outside of

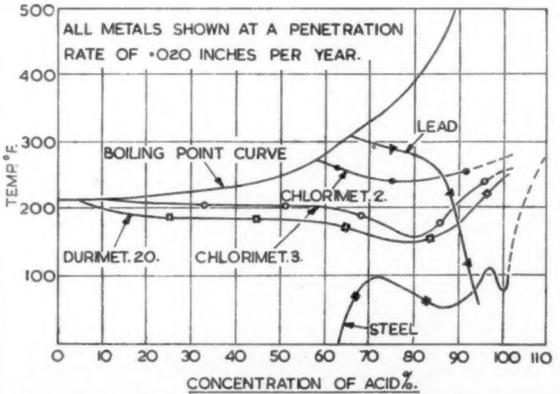


Fig. 15. Metal corrosion by sulphuric acid (penetration rate 0.020 in./yr.).

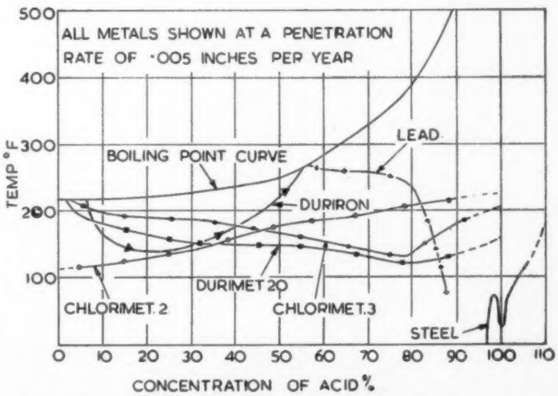


Fig. 16. Metal corrosion by sulphuric acid (penetration rate 0.005 in./yr.).

the pipes. The gaskets were of *Fluon*-sheathed synthetic rubber, the flanges of bakelite.

Certain silicones are said to have good resistance to low concentrations of sulphuric acid at low temperatures.

Organic substances including carbon. The behaviour of impregnated carbon in sulphuric acid over a range of temperatures is shown in the graph (Fig. 17).[4] Briefly it is safe to use impregnated carbon in 70% acid up to 120°C., or in 80% acid up to 60°C.

The synthetic resins are useful substances as materials of construction in sulphuric acid manufacture, particularly at fairly low temperatures. We can recommend polythene (particularly that form containing carbon black, which is added to radiate light injurious to polythene) for all concentrations of sulphuric acid up to 94% and below 65°C. It forms a hard skin with the higher concentrations of acid, but we have not found this to be deleterious. It is not suitable for oleum, with which it hardens and cracks. *Fluon* is suitable for all concentrations of acid, including oleum, up to 327°C., after which there is a slight drop in strength, although even up to 400°C. it resembles a hard rubber and there is no actual flow.

Terylene[5] is resistant in accordance with the following table:

Temp.	40°C.	60°C.	80°C.	100°C.
Conc.	70%	70%	70%	50%
% Initial strength after 72-hr. immersion:				
	100%	96%	58%	36%

Rubber, chlorinated rubber (67% Cl) and neoprene appear to be suitable for cold acid up to 50%, and chlorinated rubber for temperatures up to 50°C. at this concentration.

Cements and packing materials. The commonest and best cement is silicate cement made of a mixture of water-glass, sand and a trace of sodium silico fluoride. It is suitable for all acid compositions and all temperatures.

Sulphur cement is suitable for 70% acid up to 50°C.

None of the synthetic resin cements are really satisfactory. Furan is suitable up to 50% hot acid, 80% cold. Phenol formaldehyde is suitable up to 90% acid cold.

The best packing we know for acid pump and valve glands, stuffing boxes, etc., is blue asbestos cord soaked in a molten mixture of 6 parts of plumbago, 4 parts of mineral jelly and 10 parts of cersine wax.

For acid and sulphur line joint gaskets, we find James Walker's *Sulfesto* brand is very satisfactory. For gas and air lines we find *Bellite* grade is very good.

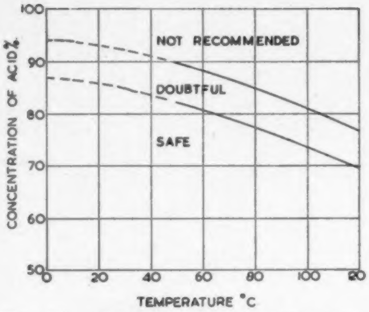


Fig. 17. Corrosion of impregnated graphite in sulphuric acid.

For steam joints we have found very suitable *Metaflex* gaskets made from spirally wound strip of V-shaped 18-8 stainless steel with an inlay of asbestos paper between, the whole being placed in a mild-steel annule, whose thickness determines the distance to which the joint has to be taken up (Fig. 19).

Absorption usually takes place in an acid-resisting, brick-lined tower packed with rings and topped with Berl saddles. The distribution is usually affected by four cast-iron quadrants fitted with dip pipes. The acid run off is usually made of silicon iron (Fig. 20).

(i) Acid cooling

The acid is cooled in serpentine cast-iron pipes sprayed with water. We have found that these pipes invariably fail from external corrosion and the corrosion is particularly virulent with saline water. Prior to the pipes failing they build up a coating of scale which considerably reduces the transmission of heat. Our experiments have shown that, if these pipes are painted (preferably sprayed) with a PVC-based paint (Croda *Metavin*), both of these effects are prevented. A further improvement we have found is to use spun cast-iron pipes, which are more uniform in density, blow holes are not produced and a thinner-walled pipe can be used. Such a pipe is cut to length and screw-flanged.

(j) Storage and transport of acid

Tanks for the storage of sulphuric acid should be supported on a grillage, as invariably at some time in the life of a tank it leaks, and a grillage gives the best chance of easy location of the leak. For cold acid above 80% concentration, the tanks should be of mild steel of welded construction; below this concentration the tanks should be of lead. If there is any chance of the acid being much above atmospheric temperature the tank should be acid-brick lined.

(k) Concentration of acid

The earliest form of concentration of acid was by the use of platinum stills; then followed the cascade process by which acid overflowed from a series of volvic stone pans set on a series of steps over a furnace. A development was the Kessler concentration, in which these volvic pans

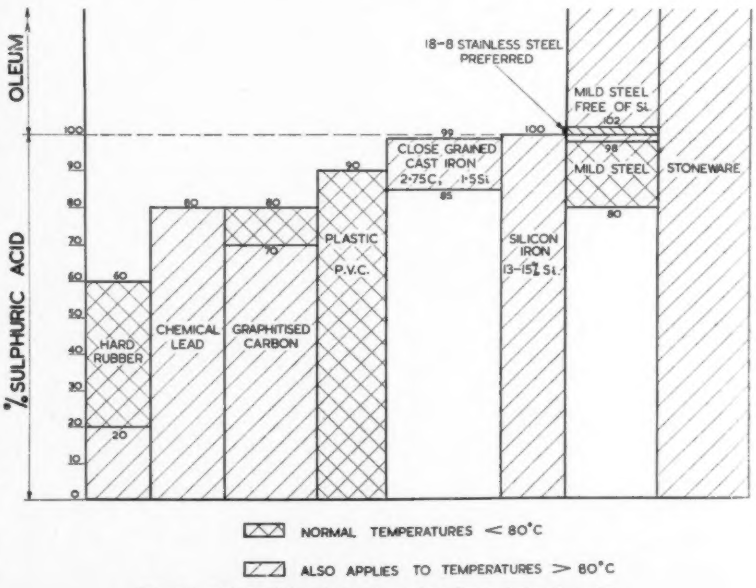


Fig. 18. Materials of construction for sulphuric acid.

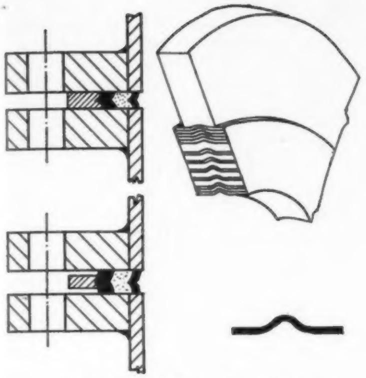


Fig. 19. 'Metaflex' gasket.

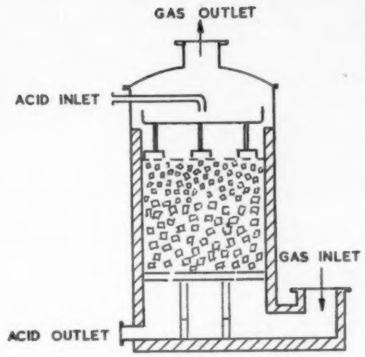


Fig. 20. Absorber tower.

were set over one another in a tower and acid trickled down the tower from one pan to the next. The tower was made of acid-resisting brick and silicate cement. The top two trays sometimes consisted of a series of porcelain bubble caps.

Another development was the use of cast-iron pots set in a gas or coal furnace. Dilute acid was led into the pot through a tower or dephlegmator constructed in cast iron lined with lead, faced with acid-resisting brick and packed with quartz chips. The hot gases from the pot passed counter-current to the feed acid and thus pre-heated it. The concentrated acid overflowed from the pot through a dip pipe.

Recently two methods have come into vogue. The climbing film evaporator consists essentially of a series of pipes up the inside of which dilute liquor and steam rise under reduced pressure and steam is flashed off at the top. The pipes can be made of glass, although it is usual for cast iron to be used.

The drum concentrator consists essentially of a mild-steel boiler lined successively with lead- and acid-resisting brick and divided into two or three compartments in acid-resisting brick. Hot gases from a furnace are passed into the first compartment whilst dilute acid is added to the third, the hot gases are led into the acid below the surface with dip tubes (which are sometimes made of silicon iron, although tantalum-lined mild steel is considered economic), the vapours from the first compartment are led into the second again below the surface and subsequently the vapours from this compartment are led into the third.

The choice of materials of construction for any plant is one of the most important decisions a chemical engineer is required to make; we trust that the information we have assembled will be found of use to him.

The authors acknowledge with thanks the permission of the directors of Fisons Ltd. to publish this article.

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Petrochemicals project

Important developments in the manufacture in Great Britain of new industrial chemicals from petroleum are announced by Monsanto Chemicals Ltd.

The company plans to spend some £8½ million on the first stage of a long-term expansion programme. As was indicated in the company's report for the year 1955, a new factory will be constructed on a 100-acre site alongside the Fawley, Hampshire, refinery of the Esso Petroleum Co. Ltd., from which Monsanto will draw feedstock for conversion into a wide variety of raw materials for use in the plastics, textile, rubber, paint, paper and other manufacturing industries.

The first plant to be erected will be for the manufacture of 10,000 tons p.a. of polythene. Survey work is being carried out on the site, construction will begin shortly and production is scheduled to start in 1958.

The next products in the company's programme will be copolymers of acrylonitrile, butadiene and other monomers. The copolymers have a wide range of uses in the rubber, paints, plastics, paper and other industries.

Following this, a major plant is to be constructed for the manufacture of acrylonitrile, an important chemical not yet made in Britain. Acrylonitrile is an essential raw material for synthetic polymers and synthetic fibres used in the production of high-quality clothing materials and other textile fabrics.

British Standards

Dipping thermometer (B.S. 2720: 1956, 2s. 6d. net). A new standard, containing recommendations for a single, standardised type of dipping thermometer, which is designed primarily to meet the requirements of the three Services, but will have a general application in industry and the home.

Jacketed pans (B.S. 2647: 1956, 2s. 6d. net, 'Steam-heated jacketed pans for processing industries (excluding catering equipment)'). Three different pressures have been selected —40, 80 and 100 p.s.i.—these being the pressures most commonly in use. This standard applies specifically to steam-heated jacketed pans for use in the processing of food, chemicals and other materials. The pan depth and shape are such that the contents can be readily observed and ladled out if necessary. Dimensions for pans with both hemispherical and dished bottoms are specified; and recommendations in relation to various components are given. Requirements for hydraulic testing and for marking are also specified.

Rubber compounds (B.S. 2751: 1956, 2s. 6d., 'Vulcanised butadiene/acrylonitrile rubber compounds,' and B.S. 2752: 1956, 2s. 6d., 'Vulcanised chloroprene rubber compounds'). These two standards, B.S. 2751 and B.S. 2752, continue the series started with the issue of B.S. 1154, 'Vulcanised rubber compounds' and B.S. 1155, 'Vulcanised extruded rubber compounds and tubing,' specifically intended for Government department use. Each standard covers five synthetic rubber compounds ranging from 41 to 88° B.S. hardness and gives details of compositions which, however, allow some latitude to the manufacturer in formulating his mixes, together with details of skeleton mixes which have been found to meet the requirements of the standard.

ION EXCHANGE

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Inorganic technological applications, including metallurgical extraction processes; water softening and demineralisation; purification and recovery

THE use of cation-exchange resins of various types in water-softening, demineralisation and related processes has been known for many years, and has already been extensively reviewed in CHEMICAL & PROCESS ENGINEERING by Hutcheon.[1] Although these subjects will again be briefly dealt with, the main body of this review will consider those inorganic technological applications which are based on somewhat different principles. In particular, attention will be drawn to the increasing importance of complex formation in inorganic ion-exchange systems. The field of application of complex formation does not lie simply in the use of complex eluting agents, as in the now classical methods used for the rare earths separation, but also in the property of complex formation to enhance the sorption of a desired species or to eliminate the sorption of unwanted ones. In its turn the increased application of complex formation has lead to a considerable increase in the large-scale application of strong base anion-exchange resins.

It is significant that many of the newer inorganic applications of ion-exchange stem from pure research work carried out over the last decade which had no specific industrial application in view, but only the accumulation of pure chemical knowledge. As the use of ion-exchange methods in the study of inorganic complex systems is still hardly out of the preliminary stage, the number of possible technological processes utilising complex formation should rapidly increase as our basic chemical knowledge of complex-compound systems increases. A recent review on the use of ion-exchange resins for the study of inorganic complex systems has been recently published by Salmon.[2]

Although there are numerous new applications of ion-exchange methods in the literature, there do not appear to have been any spectacular advances in the use of new ion-exchange materials in the last year. The field of application of ion-exchange membranes continues to expand, although difficulties over their mechanical properties do not yet appear to have been completely overcome, so still somewhat hindering their large-scale application. However, these mechanical problems should be overcome in the near future, especially in view of the vigorous efforts of the manufacturers to overcome the difficulty. The use of membranes would appear to be potentially very important industrially, as their use eliminates all problems of resin regeneration, still one of the chief economic disadvantages of the ion-exchange method.

It should also be noted that our basic physical chemical knowledge of ion-exchange membranes is still extremely limited, this being forcibly brought out in the recent Faraday Society discussion at Nottingham.[3] Indeed, until more fundamental knowledge is to hand the full potentialities of ion-exchange membranes can scarcely be evaluated.

The subjects to be considered in this review will be listed for convenience under various headings as follow:

METALLURGICAL EXTRACTION PROCESSES

Uranium extraction

The most important extraction process yet developed is that for uranium, which has received great attention due to the demands of the atomic energy programme. This process is an excellent example of the use of complex formation to enhance the sorption of a desired species present in low concentration, and in the presence of excess quantities of unwanted materials. Owing to the present inflated price of uranium, very low-grade ores have to be used, often with an uranium concentration of only about 100 p.p.m.[4]

The ore is finely ground and is then leached with sulphuric acid, often after addition of manganese dioxide to ensure oxidation of the uranium to the hexavalent state. Given an average recovery of 90 to 95%, and an overall dilution factor of 4, the final leach solution will contain 20 to 25 p.p.m. of uranium.

As the concentration of other metals (principally iron) in the pregnant liquors are usually at least a hundred times greater than this figure, conventional chemical methods for uranium separation would be difficult and costly to apply. It has been found, however, that hexavalent uranium forms an anionic complex $[UO_2(SO_4)_3]^{4-}$ in presence of excess sulphate, and that this complex is strongly sorbed by the resin. Indeed in aqueous solution it is considered that hexavalent uranium is present in sulphate media either as uncomplexed UO_2 ions or as unionised UO_2SO_4 molecules, and that the sulphate complex is present only in trace quantities.[5, 5a] However, this complex ion is so strongly sorbed by the resin that the equilibria (1) and (2) are almost completely displaced to the right:

$$(1)\ UO_2^{++} + 3SO_4^{=} \rightleftharpoons [UO_2(SO_4)_3]^{4-}$$

$$(2)\ [UO_2(SO_4)_3]^{4-} + 4RCl \rightleftharpoons R_4[UO_2(SO_4)_3] + 4Cl^-$$

In other words, the presence of the resin causes the formation of large quantities of a complex ion which otherwise is present in only negligible concentration. If the resin is in the sulphate form instead of the chloride form as given in (2), then the sorption stage can be written:

$$(3)\ UO_2SO_4^{=} + 2R_2SO_4 \rightleftharpoons R_4[UO_2(SO_4)_3]$$

implying that a complete sorption process is being encountered.

As indicated by equation (3), if pure uranyl sulphate solution containing no free acid is passed through a column of the sulphate form of the resin, then the whole of the uranium and sulphate present in solution are sorbed by the resin, and the liquor emerging from the column is effectively pure water. This fact again emphasises the importance of the resin in the formation of the complex uranium sulphate anion and illustrates the large modifications of normal ion-exchange be-

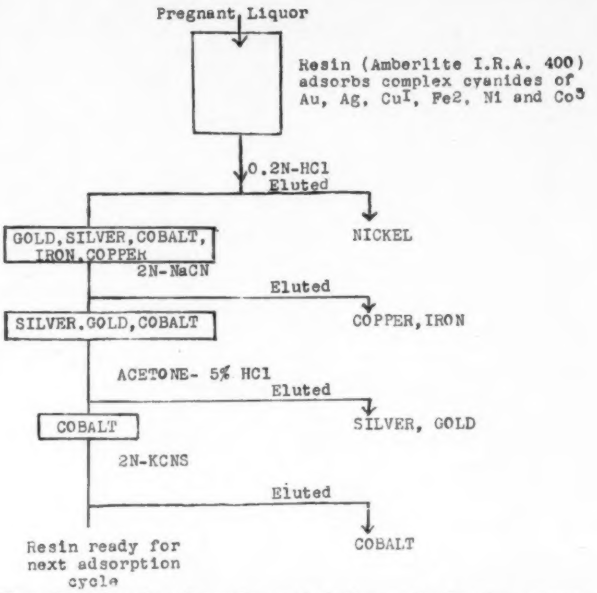


Fig. 1. Flow sheet for the adsorption and elution cycles for the concentration of gold from pregnant cyanide solutions by means of a strong-base anion-exchange resin.

haviour which are liable to occur with inorganic complex systems.

The only other system where similar behaviour has been reported is that of quadrivalent germanium and sulphate where the $[GeO_2(SO_4)]^{2-}$ ion is sorbed by the resin, although this complex anion cannot be detected in solution by other physical means.[6]

In plant practice the pregnant sulphate liquor, after leaching the ore with sulphuric acid, is clarified by filtration, its *p*H is adjusted to 1.5 (minimum value) and it is then passed through a column of the sulphate form of the resin.[5, 7, 8] The *p*H of the solution should not drop below 1.5, otherwise the capacity of the resin for uranium drops sharply; nor should the *p*H rise above 4, otherwise hydrolysis of the uranium solution occurs. The pregnant liquor is passed through the column until the uranium concentration on the resin has reached an economic level. A very large degree of concentration is afforded at this stage, uranium concentrations of 0.5 to 1 g./l. in the pregnant liquor being increased to 10 to 20 g./l. in the ion-exchange eluate.[7, 8] It has been found[5] that resin loadings of 110 g. U_3O_8/l. or 7 lb./cu.ft. of resin can be obtained, although in practice 5 lb./cu.ft. loadings are more common.

A certain amount of ferric iron, presumably in the form of $[Fe(SO_4)_3]^{3-}$ anions, is also sorbed along with the uranium, but as the affinity of the ferric complex for the resin is less than that of the uranium complex, the degree of contamination is quite small (about 5%).

The uranium is eluted from the resin by a slightly acidified solution of any inorganic salt except sulphate, nitrate-nitric acid mixtures being the most popular. Elution is very efficient because the use of non-complex-forming anions such as nitrate not only displaces the complex $[UO_2(SO_4)_3]^{4-}$ ions, but also causes their breakdown to give UO_2^{++} cations which are not sorbed by the anionic resin.

In South African practice[7] it is reported that iron in the eluate is removed before the uranium by adjusting the *p*H to 3.7 by addition of milk of lime which causes precipitation of ferric hydroxide. This does not appear to be American practice,[8] the uranium in the eluate being precipitated as ammonium diuranate $(NH_4)_2U_2O_7$ by addition of ammonia to give a *p*H of 6.9, this salt being finally ignited to give U_3O_8.

Resin-in-pulp process of uranium extraction

An important modification of the above uranium extraction method is the resin-in-pulp process.[8] This no longer requires the resin feed to be water clear, and allows the use of acid leach liquors which have difficult thickening characteristics. The resins used are the same as in the column process, but the particle size is much larger. The manufacture of these large resin beads was apparently a matter of difficulty, although it is now claimed that this problem is solved. These large resin particles are placed in stainless-steel baskets which have openings smaller than the resin beads, but larger than the particles in the pulp fed into the process. The sulphuric acid leach liquor is first passed through a sand-slime separator to remove coarse particles. The pulp is then fed under gravity into a series of cells containing baskets partially filled with resin. The baskets are then slowly moved up and down in the pulp by means of an overhead drive, thus ensuring good contact between the pulp and the resin. The uranium from the pulp is then directly sorbed by the resin beads, and the barren pulp discarded, the difficult and costly solid-liquid separation step being thus eliminated. The uranium is eluted from the resin by passing the eluting solution through the cells containing the baskets, which are agitated as before. Further details of this method have been given by Hollis and McArthur.[9]

Gold recovery

This procedure depends upon the adsorption of a number of complexes by the resin, which are then separated at the elution stage.[10] Pregnant liquors after cyanidisation of the gold ore contain, as well as aurocyanide, ferrocyanide, cuprocyanide, argentocyanide, usually some cobaltocyanide and nickelocyanide, and sometimes some zincocyanide as well. The main features of the process are illustrated in Fig. 1.

The mixed heavy metal cyanide solution is passed down a column of *Amberlite I.R.A.* 400 in the chloride or cyanide forms. The heavy metal cyanides are all sorbed by the resin. After washing, the resin is eluted with 0.2N-hydrochloric acid which removes nickel and zinc, but only negligible quantities of other metals. Similarly, iron and copper cyanides are eluted with 2M-sodium cyanide. Gold and silver were found to be very difficult to elute with inorganic reagents, and a mixture of acetone-5% hydrochloric acid was found to be one of the few efficient eluting agents. Cobalt cyanide resisted elution strongly, but could be removed from the resin by means of 2M-sodium thiocyanate. It was not necessary to elute the gold after each adsorption cycle, the gold loading on the resin being allowed to build up until it reached an economic value.

DEMINERALISATION

The principles of water softening and demineralisation can now be con-

sidered well known, so that attention will be given in this section to the high state of automation which can be secured in modern practice. An excellent illustration of this factor is given by the recently published account of the control system of the Raritan River plant of the Jersey (U.S.) Central Power Co.[11] The water is demineralised by a unit consisting of anion and cation sections joined in pairs, each section being controlled by a separate anion control panel and cation control panel. The whole demineralising plant is housed in a separate lean-to structure adjacent to the main building, thus facilitating delivery of chemicals and avoiding any chemical mixing inside the main plant. The chemical charges for regeneration are mixed during the day shift in order that they may be available whenever needed. The semi-automatic twin-bed demineraliser, and the regeneration cycle, must both be started manually. Gravity-fed city water passes through the de-demineralisers to the condensers, the flow rate being set to the optimum for the number of demineralisers in service. When water demands are satisfied, alarms are sounded and the demineraliser is stopped manually. Any rise in the solid content of the purified water is detected conductometrically, an alarm is sounded and the demineraliser unit is automatically taken out of service and replaced by a regenerated unit. When needed, regeneration of the units must be started manually, cycle timers carrying out the regeneration, backwashing, etc., and an alarm being sounded when the unit is once more ready for service.

PURIFICATION AND RECOVERY

Treatment of pickling liquours

An excellent example of purification and recovery is given by the ion-exchange treatment of spent sulphuric acid pickling liquors. It has been estimated that nearly a billion (small) gallons of such pickle solutions are produced annually in the U.S. alone, the average composition being 15% ferrous sulphate and 5% free sulphuric acid. These solutions provide a great disposal problem and much effort has been made to find recovery processes which could be operated at a profit or at net zero cost.

Fradkin and Tooper[12] applied straight ion-exchange procedures to this problem. They passed pickling solutions down a column of cationic resin in the acid form, when a simple conversion of ferrous sulphate to sulphuric acid took place:

$$[2RH + Fe^{++} \rightarrow R_2Fe + 2H^{+}]$$

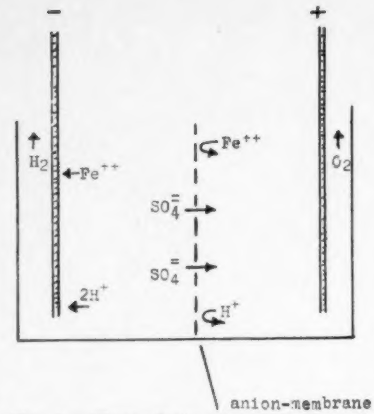


Fig. 2. Electrolysis of a solution of ferrous sulphate and sulphuric acid with an anion-exchange membrane between the electrodes.

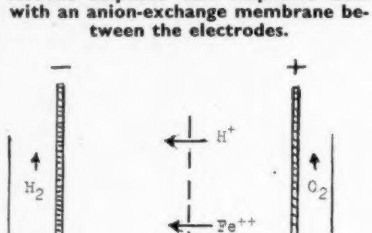


Fig. 3. Electrolysis of a solution of ferrous sulphate and sulphuric acid with a cation-exchange membrane between the electrodes.

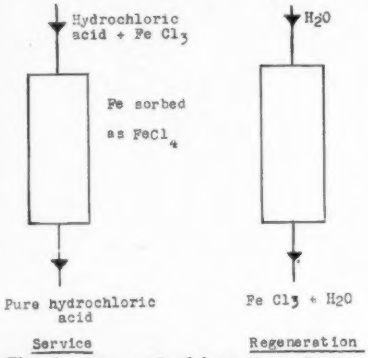


Fig. 4. Removal of iron from hydrochloric acid by means of a strong-base anion-exchange resin.

Although this is the required result, *i.e.* the formation of pure sulphuric acid, there are a number of practical difficulties. Great care has to be taken to prevent iron ' leakage ' through the column due to channelling and subsequent incomplete exchange.

An interesting alternative process is to electrolyse these pickling solutions with an anion-exchange membrane between the electrodes. The removal of iron from ferrous sulphate-sulphuric acid solutions is not possible by conventional electrolysis; at acid concentrations above about 2 g./l. the current efficiency for iron deposition quickly drops and hydrogen is evolved from the cathode, *i.e.* the net effect is just to electrolyse water. If an anion-exchange membrane is placed between the anode and cathode (Fig. 2) the result is quite different.[13] Sulphate ions migrate through the membrane into the anode compartment where they build up in concentration due to the preferential discharge of OH^- ions. Cations cannot get through the membrane, so that there is an effective build up of sulphuric acid concentration in the anode compartment.

A cation-exchange membrane (Fig. 3) would act differently; hydrogen ions will penetrate the resin more quickly than will ferrous ions due to their greater mobility in the resin phase, so that there will be a build up of sulphuric acid in the cathode compartment. However, it will clearly be more efficient to use the first procedure with the anion-exchange membrane, as there will then be no interference due to competing iron transport.

Difficulties also occur with the membrane method, the chief being to obtain membranes with sufficient mechanical strength to give an economic life. There is also a loss of theoretical current efficiency due to leakage of hydrogen ions through the membranes into the cathode compartment. Like all membrane processes, this method possesses the outstanding advantage of eliminating the expensive elution step and of being a continuous process.

Ferric iron from hydrochloric acid

An elegant example of purification is given by the method of separating ferric iron from hydrochloric acid using anion exchange. This process makes use of the original observation of Kraus and Moore,[14] who showed that ferric ions, along with a number of other metal cations, formed chloro-complexes in strong hydrochloric acid which could be taken up by a strong-base exchanger. The method described here, due to Reents and Kahler,[15] makes use of this simple principle of Kraus and Moore; the chief points of their process are illustrated in Fig. 4.

The contaminated acid passes through a column of the chloride form of the resin, and purified acid is delivered directly from the bottom of the column. At the end of an operating

(*Concluded on page* 372)

Some Industrial Applications of FOAM

By N. Pilpel, PH.D., B.SC.

The nature of foam and the manner in which it is produced are briefly explained; the article then goes on to discuss applications of foam including foam flotation, fire fighting, solid foams and miscellaneous other applications.

WHEN Plateau[1] carried out his experiments on foam in the 1860s he could hardly have imagined that a century later foam would be used for such widely different purposes as extracting metals from their ores, extinguishing fires, building schools, and destroying agricultural pests. Foam had been recognised as a state of matter from very early times, and it had been employed in baking, brewing, cooking, and laundering for over 2,000 years, but it was not until Plateau's time that a clear understanding was gained of its nature and properties, and it was partly as a result of his pioneer work that it became possible to extend the uses of foam to new, and developing industries.[2]

Very simply, a foam consists of small bubbles of gas which are separated from each other by thin boundaries. These may be either liquid or solid, although in the particular case of a three-phase foam (Fig. 1) the boundary is liquid with very small particles of solid immersed in it. There are many factors which determine the stability of a foam and, of these, the most important are the surface tension, viscosity and elasticity of the boundary layers. In the case of three-phase foams the solid particles prevent the bubbles from coming close enough together to coalesce, and solid powders such as lead sulphide, carbon black, etc., are frequently used for stabilising foams.

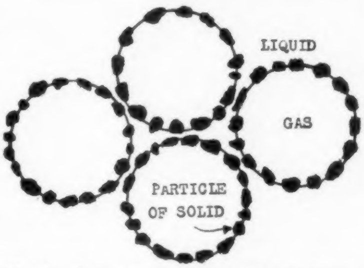


Fig. 1. Structure of three-phase foam.

Courtesy: J. Soc. of Dyers and Colourists

Fig. 2. Foam consisting of large bubbles. The junction between them is indicated by the four-pointed star.

How foam is produced

Foam can be produced in many ways; for example by whipping, beating, or injecting gas through a fine nozzle into a suitable liquid. The bubbles can range in size from microscopic up to several centimetres in diameter (Fig. 2) and, depending on their uniformity in size, their shapes can vary from almost spherical to irregular polyhedral.

Nearly all the liquids which occur in nature will foam, examples being fruit and vegetable juices, raw rubber, crude mineral oil, egg white, sea water, milk and many other body fluids. The most notable exception is pure water, and it is now known that the ability to foam is conditional on there being present in the liquid small amounts of special substances known as foaming agents. Without these a foam is unstable, and this is why it has not been possible to produce foams in pure liquids, which only contain one component.

Foaming agents are of many types: probably the best known is soap, which has been employed for centuries. Others include proteins, amino acids, alcohols, esters and acids whose molecules contain long chains of carbon and hydrogen atoms, synthetic detergents, finely divided solids, etc. The natural liquids that we have mentioned usually contain several different foaming agents. Thus, egg white and sea water contain proteins, amino acids and salts; fruit juices and raw rubber contain glucosides, acids and esters; and crude mineral oil, resinous particles and sulphonic acids. It is a well-known fact that, after oil has been freed from resins and acids by refining, it foams much less readily than when in the crude state.

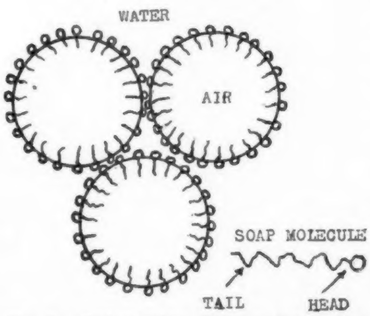


Fig. 3. Orientation of soap molecules in foam.

Function of foaming agents

The molecules of nearly all foaming agents are made up of two distinct portions. The first, the 'head,' consists of such groups as –OH (hydroxyl), –COOH (carboxylic acid), etc.; the second, the 'tail,' of long chains of carbon and hydrogen atoms. The 'heads' are soluble in water but insoluble in oil, while the reverse holds for the 'tails.' Let us consider what happens when air is bubbled into an aqueous solution of a soap such as sodium oleate.

As the bubbles are produced the molecules of soap migrate to the air-water boundaries and orientate themselves with their 'heads' in the water and their 'tails' in the air (Fig. 3). In this way contact between water

and the insoluble 'tails' is reduced to a minimum and this represents the most stable arrangement for the molecules. The result of the migration is that the concentration of soap in the boundary layers becomes higher than in the bulk of the liquid, and this leads to a decrease in the surface tension, and an increase in the viscosity and elasticity of the boundaries. These are the necessary conditions for bubble stability.

A very great stimulus to the employment of foam in commerce and industry was due to the discovery of synthetic detergents which occurred towards the end of the last century. Synthetic detergents, initially developed to relieve the demand by soap makers for natural oils and fats which were required as foodstuffs, were particularly effective foaming agents. The fact that they could be literally 'tailored to shape' so that they would operate in the presence of acids and salts, where soap would have been precipitated, rapidly led to their adoption in industrial processes. And certainly one of the most novel of these at the time was in connection with the winning of metals and minerals from their ores.

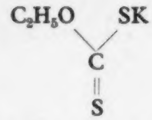
Foam flotation

Foam flotation involves mixing finely ground ore with water and then causing it to foam. If the mixture has been suitably pretreated it is found that the particles of the valuable mineral concentrate in the foam, while the particles of unwanted rock remain in the bulk of the liquid. When the foam is skimmed off it yields a concentrate of the valuable mineral, and this can then be subjected to the usual processes of extraction and refining.

The first process that employed foam flotation on the commercial scale was due to C. V. Potter in 1901 and was applied to recovering zinc and lead sulphides from wastes and slags at Broken Hill in Australia. In this process the crushed ore was immersed in hot, acidified water and the bubbles of gas, liberated as a result of chemical reaction between the acid and the ore, attached themselves to the metallic sulphides and raised them to the surface of the mixture. But the original process was soon modified.

Nowadays the crushed ore is first treated with chemicals known as collectors, which attach themselves to particular particles in such a way as to render their surfaces 'oily.' One example will illustrate how this occurs.

Suppose a collector such as potassium ethyl xanthate

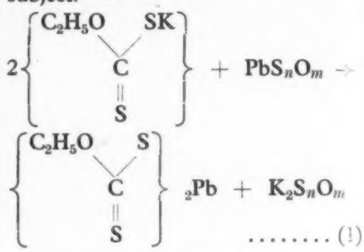


has been added to a mixture containing lead sulphide, calcium fluoride, and silica. Reaction between the xanthate and the sulphide occurs according to equation (1) and each particle of lead sulphide becomes encased in a layer of xanthate molecules whose hydrocarbon 'tails,' orientated outwards (Fig. 4), render the surfaces of the particles 'oily.' If a foaming agent, such as a detergent, is now added and air bubbled into the mixture, the 'oiled' particles will stick to the bubbles and rise with them to the surface, while the particles of fluoride and silica, which have not been rendered 'oily' by the xanthate, will be unable to stick to the bubbles and will remain in the bulk of the liquid. In this way the valuable sulphide is separated from the remaining minerals.

Activation and deactivation

In actual practice the flotation process is more complicated than this, and special measures frequently have to be taken to ensure that clean separations are obtained. Thus, for example, zinc sulphide will not normally respond to xanthates, but if the crushed ore is first treated with a small amount of a soluble copper salt, *e.g.* copper sulphate, a very thin film of copper sulphide is deposited on the zinc sulphide and collection can then proceed normally.

Such pretreatment, designed to make a mineral respond to a collector, is termed activation, the activating agent here being copper sulphate. The reverse process—deactivation—is employed to prevent one collector from simultaneously collecting several different minerals which may be present. Thus when iron, zinc and lead sulphides occur together, cyanide may be added prior to the xanthate collector. This prevents flotation of the iron and zinc, but leaves the lead sulphide unaffected. Under these circumstances cyanide is operating as the deactivating agent. Further details on activation and deactivation will be found in a number of textbooks on the subject.[3, 4, 5]



Flotation equipment

Foam flotation is carried out in many types of machines, of which a modern type is the sub-aeration machine. This consists of cells in which the ore and water are stirred by a hollow, rotating impeller. Air, passed through the impeller, causes the mixture to foam, and this is collected by allowing it to spill over into a gutter running along the length of the machine.

Initially only a few thousand tons of ore a year were subjected to flotation treatment, but with the growing demand for minerals and metals the process has been widely adopted. Nowadays it is employed in the extraction of ferrous and non-ferrous metals, uranium, coal, graphite, sulphur, calcite, borax, sulphates, carbonates, etc. Several flotation plants operate at the rate of 10,000 tons/day of ore, and others with substantially greater capacities are being planned for the near future.[6]

Foam in fire fighting

The fundamental principle upon which foam flotation depends is that different mineral substances are adsorbed to different extents at the boundaries between a gas and a liquid, and the particular merit of foam in the flotation process is that it affords a very large contact area between different phases. Advantage is taken of this same property of foam when it is employed for fighting fires. Here the aim is to blanket the burning substance from the atmosphere above,

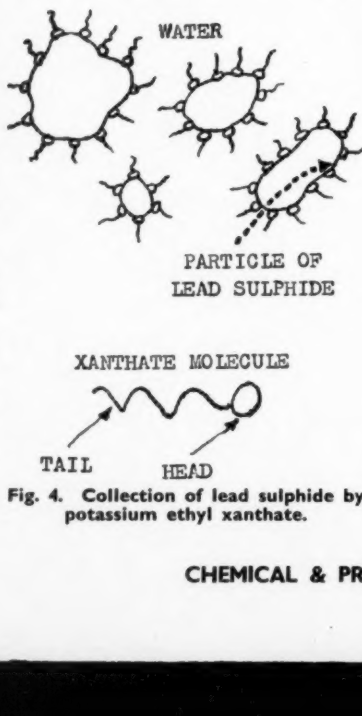


Fig. 4. Collection of lead sulphide by potassium ethyl xanthate.

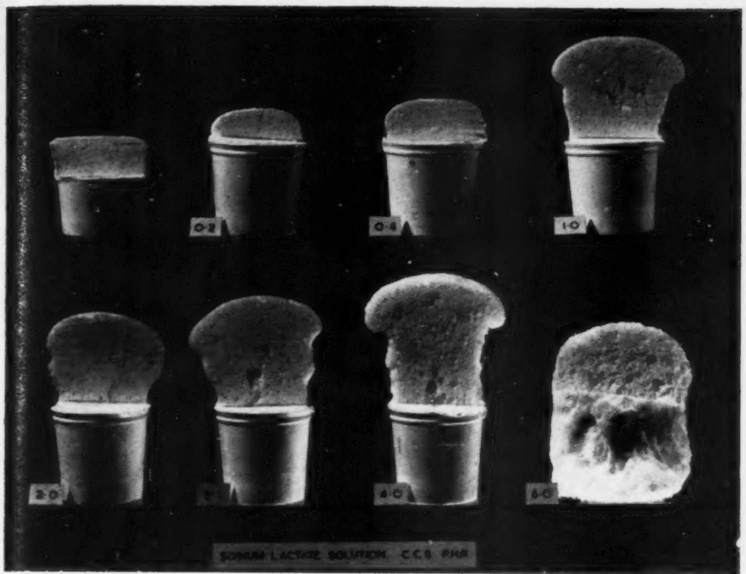


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Fig. 5. Effect of sodium lactate accelerator on the structure of a 'Sebalkyd' foam.

cutting off the supply of oxygen. For it is the rapid chemical combination of oxygen with carbon and hydrogen in the inflammable object that leads to the phenomenon of burning. The blanket here is a layer of an inert gas, such as carbon dioxide, which is held in intimate contact with the burning object in the form of a foam in water.

The employment of foam for fire fighting was adopted first in Russia at the beginning of the 20th century, when it was used to extinguish burning naphtha. The foam was produced by mixing aluminium sulphate and sodium bicarbonate in water, a small amount of saponin being added to act as the foaming agent. Chemical reaction between the main ingredients generated carbon dioxide in the water and this produced a closely knit foam which spread over and extinguished the flames. Although the original patents were taken out over 50 years ago there has been very little change to the chemicals actually used to generate fire-fighting foams, and sodium bicarbonate and aluminium sulphate are still the most frequently used.

The main developments have been in the choice of the agents that are used to stabilise and preserve the foam. Thus, prior to 1939 the most frequently employed were saponin and synthetic detergents, but since then hydrolysed proteins, derived from soya beans, fish scales, and hoof and horn meal, have been adopted. Again, the original practice of mixing aqueous solutions of sodium bicarbonate and aluminium sulphate has been superseded, and nowadays the tendency is to incorporate all the ingredients into one, or two, powders which produce the foam when added to water.

Chemical generation of foam is carried out in a variety of equipments. In one type a charge of 2½ gal. with 2 gal. of water yields about 24 gal. of foam, while in another the charge is 40 gal. and with 33 gal. of water produces between 350 and 400 gal. of foam. The efficiencies of the different equipments are conveniently compared by using them to extinguish standard fires.

Besides the chemical method of generation, fire-fighting foams are also frequently generated by mechanical methods. The principle here is to introduce about 5% of a foaming agent, such as saponin, into water and then bubble carbon dioxide in. Soaps, detergents and ferrous sulphate are frequently added to increase the stability of the foam, particularly when burning solvents are involved. In general, mechanically produced foams are more effective than those produced chemically and, since they can be generated in almost unlimited quantities, are particularly useful against major conflagrations.

The rheological and physical properties of a foam markedly influence its ability to extinguish a fire. Thus the viscosity must be low enough for it to spread rapidly, but at the same time the elasticity and coherence must be sufficiently high for the foam to hold together when it flows over solid obstructions. Again, the density must be great enough for the foam to sink well into the fire, and not to be dispelled by wind and convection currents. Much work has been done on these aspects of fire-fighting foams and various reviews have been published.[2, 7]

Solid foams

We come now to the third major use which has been found for foam in recent years. This is the employment of solid foam as a material of construction. Barely a quarter of a century has elapsed since solid foams for this purpose appeared on the market, but in the ensuing period progress has been extremely rapid, and there is every indication that solid foams will increasingly replace more conventional materials in a large number of fields.

Solid foams differ from liquid foams only in the fact tha the boundaries between the bubbles are now solid. As before, they are made by introducing bubbles of air or other gas into a suitable liquid which is then caused to solidify, either by cooling or by evaporation of the solvent in which the material of the foam has been dissolved. Thus rubber and glass are made to foam when in the molten state and then cooled, while many plastics are dissolved in a solvent which rapidly evaporates as gas is bubbled in.

There are a number of naturally occurring solid foams, of which probably the best known is pumice stone. This is found in Italy, Iceland, East Africa, Mexico and other volcanic regions, and is presumed to be formed by the rapid expansion of gases entrapped in molten rock when this is ejected suddenly from a region of high pressure up to the surface of the earth. Pumice stone itself is soft and rather brittle, but when blended with other materials such as cement, calcined straw, slag and sawdust[8] is very suitable for building purposes. It is now used as a constituent of lightweight concretes and plasters, and it has been claimed[9] that the employment of pumice in the building of schools in East Africa considerably reduces the cost and enables the buildings to be completed in one-sixth of the previous time.

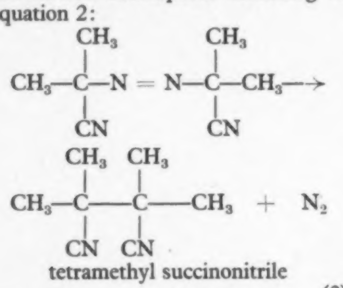
Another solid foam which has recently come on the market is vermiculite. This is prepared from a micaceous mineral which on heating to about 1,100°C. loses its water of crystallisation in the form of steam. This causes it to swell up and develop a honeycomb structure, the final density being about one-twelfth that of the original mineral. Many uses are

being found for vermiculite—as an insulator to sound and heat, as a constituent of lightweight concrete and plaster, and as a packaging material.

Preparation of solid foams

Solid foams are now prepared from a large number of natural and synthetic compounds, chief amongst which are rubber, plastics and glass. The early processes for making foam rubber[10, 11] involved mixing latex with ordinary vulcanising and compounding ingredients, foaming agents and a setting agent. The mixture was then caused to foam at an elevated temperature, either by mechanical agitation, or by blowing in a gas such as nitrogen or carbon dioxide at a pressure of 200 atm. The setting agent caused the mixture to solidify to a porous mass, and this was subsequently vulcanised at 130 to 140°C. Since about 1942, however, the tendency has been to generate the gas *in situ* by addition of suitable chemical blowing agents to the mix.

Blowing agents are compounds which decompose on heating with the evolution of gas, and a large number are now commercially available.[11] The earliest used was sodium bicarbonate, which, however, suffers from the disadvantage of being difficult to disperse in a rubber or plastic mix, and it has therefore been largely replaced by organic agents which suffer less from this disadvantage. Examples of these are pp′ Oxy- bis (benzene sulphonhydrazide), known as O.B., which is used with rubber, epoxide resins, polyvinyl chloride and polythene; dinitroso-pentamethylene tetramine, known as *Vulcacel*; and azo- isobutyronitrile, known as AZDN. The last named decomposes according to equation 2:



tetramethyl succinonitrile

.... (2)

yielding about 125 ml. of gas per gramme at 130°C. Since the tetramethyl succinonitrile that is produced combines readily with hydrochloric acid, AZDN has been of particular value in the manufacture of foamed polyvinyl chloride, and it is currently employed in the U.S., U.K., Canada, France, Germany and Holland.

Properties of solid foams

The properties of solid foams depend on the material that has been used, but are also markedly affected by the conditions under which the foam is generated and stabilised. Broadly speaking, solid foams are of two types—the hard, rigid type, and the soft, flexible type. Many plastics can be made to yield either type. Thus polyurethane foams, which are normally produced by mixing together a liquid alkyd resin and a di-isocyanate, become increasingly elastic as the molecular weight of the alkyd is increased. But the method of mixing, temperature, and presence of small amounts of accelerators, which control the rate of gas evolution, alter the physical properties to a marked extent (Fig. 5). Polyurethane foams were first developed in Germany during the war, but since 1946 have been widely adopted elsewhere. They are used in aircraft frames for damping out vibration and noise, in upholstery, as packaging materials, and in toilet articles such as sponges and bath mats.

Polyvinyl foams, likewise, are excellent substitutes for sponge rubber, and have the added advantage of being fireproof, while polystyrene foams, which can be fabricated to have a density between 0.6 and 0.8 g./cc. and a consistency similar to wood, are used in the form of boarding for the purpose of thermal insulation. Other plastic foams are used in tooth brushes, life-saving rafts, mattresses, tyres, clothing and electrical insulators.

Miscellaneous uses of foam

There are a number of other uses to which foams have been put and these may now be briefly mentioned. In agriculture poisonous gases, such as hydrocyanic acid, are sometimes required to destroy pests. But a gas, liberated as such, would be rapidly dispelled by the wind and not remain sufficiently long in contact with the pest to kill it. The hydrocyanic acid is therefore generated in water containing a suitable foaming agent and the resulting foam sprayed over the infected area.[12] In this form the poison is held for some time in intimate contact with the pest, but thereafter it evaporates completely, leaving no dangerous residues.

The heads of matches are prepared as solid foams consisting of air in a mixture of antimony sulphide, potassium chlorate, glue and certain other substances. The large area of contact between the air and the inflammable materials makes for smooth burning, but it is found that if the ratio of solid to gas in the foam is too high the ignited head splutters and explodes.

Foam has been used for filtering out the particles in smokes and mists, and foaming agents are sometimes added to mineral oils so that under vacuum they will froth. This enables them to be dried and degassed more readily.[13]

Finally foam is widely used in the manufacture of foodstuffs such as bread, meringues, souffles, beer, etc., to produce the desired airy consistency.

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PVC sheeting. New and revised British Standards for PVC sheeting were recently published. One, B.S. 2739: 1956, dealing with thick sheeting, is entirely new; the other, dealing with thin sheeting, B.S. 1763: 1956, is a complete revision of the existing B.S. 1763: 1951. Among a wide variety of applications, thin PVC sheeting can be used specifically in chemical plant for membrane linings for steel, concrete and wood vessels, pipe coverings, a vinyl balloon bucket for carrying liquid, a covering for fan impellors, air filters and sachets for chemical products.

Heat insulating terms (B.S. 874: 1956, 5s. net, 'Definitions of heat insulating terms and methods of determining thermal conductivity'). Part 1 of this standard contains definitions of heat insulating terms and a summarised list of relevant symbols and dimensions of units. The measurement of thermal conductivity and emissivity is described in Part 2, including methods used for different types of materials for various temperature ranges. Conversion tables for units in common use are provided in the appendices.

U.S. Research Institute Investigates

UP-GRADING OF LOW-QUALITY ORES

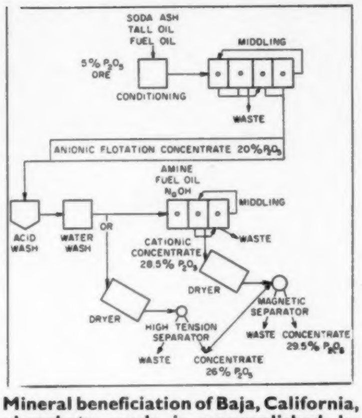
BECAUSE the United States' mining industry is faced with the fact that accessible deposits of high-grade materials are dwindling rapidly, the research budgets of mining companies are being augmented to develop profitable means of up-grading abundant lower-quality deposits and residues of earlier mining operations.

This dwindling of high-grade reserves is of special consequence to the 11 western states, historically the leading U.S. producers of such essential minerals as copper, mercury, boron, tungsten, potash, phosphate, silver and gold.

In many fields, the fruits of applied research in ore beneficiation have been amply demonstrated in recent years. For example, taconite has become a commercial source of iron, titanium is being derived from ilmenite, and uranium ores assaying less than 1% uranium are being successfully processed. Other materials being taken from ores are molybdenum, vanadium and selenium from copper ore and vanadium from uranium ore. Some ores are worked for several materials.

Taking an active lead in the beneficiation of metallic and non-metallic ores, especially in the west of the United States, have been the chemical, metallurgical and ceramic process engineers of the Stanford Research Institute, of Stanford, California. They have been assisted by the Institute's inorganic and surface chemists and economists. A strong motivating power in such work is S.R.I.'s interest in the greater utilisation of the western U.S. mineral resources and the application of such advanced techniques as organo-metallic reactions, solvent extraction and ion exchange. Because of the high cost of reagents, however, the industry has used ion exchange only in the up-grading of valuable materials such as low-quality uranium ores. S.R.I. workers are, however, exploring the application of the process to other minerals.

Selection or development of a beneficiation process is based on a thorough mineralogical, chemical and physical property evaluation by scientists, while staff economists study marketability and distribution of mineral products and costs of raw materials. The lower the grade of ore, normally the higher the cost of concentration. At the same time, however, increased market values



Mineral beneficiation of Baja, California, phosphate sands is accomplished by anionic-cationic flotation, or by anionic flotation high-tension separation, and thereafter by magnetic separation. In the conditioning step, coatings are formed on the particles. Middling is introduced to increase recovery. Acid wash removes oil film on surface of particles. Water wash removes excess acid.

of various mineral products and new, low-cost processing methods are overcoming the cost obstacle.

Beneficiation of phosphate ore

A significant example of the Stanford Research Institute's co-ordinated effort is the recent successful project conducted on the beneficiation of a phosphate sand deposit on the west coast of Baja, California. A potentially limitless source of phosphate for western U.S. and Orient fertiliser manufacturers was discovered in 30-odd miles of lagoons and off-shore bars of sand. The phosphate is found, and is replenished by natural phenomena, in the lagoons and islands as a very low-grade ore with a P_2O_5 content of 4%.

Despite its low quality, the ore became of interest for several reasons: the apparently boundless quantity and accessible location; the presence of valuable by-products such as quartz, zircon and ilmenite; and its existence as a surface deposit of unconsolidated, uniformly sized sand already washed free of slime impurities. The latter conditions made possible the by-passing of the normal pre-processing steps—mining, crushing and screening—to an upgrading procedure.

It was at this stage that S.R.I. was asked to study a number of continuous beneficiation processes to determine those most suitable for economical treatment. Combinations of up-grading techniques were studied and their cost and efficiency determined. The investigations revealed that one of the most applicable processes was the flotation method.

Froth flotation

Making it ideal for anionic flotation was the surface of the phosphate particles and particle-size distribution. In the first step of this recovery process a fatty acid film is adsorbed and reacts with the red phosphate particles, making them water-repellant but adherent to air. The coated phosphate particles are propelled upward with air bubbles in a vessel to form a froth at the surface which can be skimmed off. In the process, middling is re-introduced to increase recovery. An acid wash removes the oil film on the surface of the particles and a water wash removes the excess acid.

The product, skimmed off, contains 20% P_2O_5, but this phosphate must be up-graded to the 25 to 30% range required for commercial uses. By the subsequent separation of accessory materials such as ferromagnesians, ilmenite and zircon by cationic flotation or electrostatically, the phosphate is boosted into the desired range. By magnetic separation, impurities containing iron can be extracted for a richer phosphate. By additional treatment, the valuable by-products can be obtained in saleable form.

At this stage of the project, a 'floating pilot plant' is under consideration as well as a complete market study.

New processes for up-grading clay

Investigations by Stanford scientists into ore beneficiation has led them into other rewarding avenues. New recovery processes have been devised, profitable by-products have resulted, and new uses of materials have evolved.

For example, the potential commercial value of a 'waste' clay at Corona, California, was considerably enhanced through a settling process, whereby the clay fraction is separated from sand, grit and impurities in the slurry which collects in a Corona glass company's water-recovery system. The clay was found to have the proper viscosity and gelling properties for use

in oil-well drilling muds and to have sufficient adsorption to serve as a potential bleaching agent for various mineral and vegetable oils.

In a search for a suitable clay deposit for the north-west paper-coating industry, S.R.I. research workers decided on an Ione, California, source which previously had been of no commercial value. A chemical and physical analysis, however, showed that this deposit also contained a sand of value to the glass and refractory industries, while a carefully sized fraction of the clay has a required viscosity and particle-size distribution for use in paper coatings, though chemical treatment is required to up-grade it to the whiteness and reflectance called for by the paper industry.

The beneficiated sand is of the high-grade quality, with iron oxide and alumina impurities less than 0.04 and 4%, respectively, such as is in demand by glass makers. Because of this, the Ione 60% sand/40% clay deposit has become the site of large-scale glass sand and refractory clay plants, whose products are being used as raw materials by glass and refractory firms in the San Francisco area.

In another project, S.R.I. scientists found that an existing process was inapplicable for the recovery of vanadium from a lean ore, and a feasible technique was developed. A simultaneous comparative investigation of vanadium recovery by ion exchange and precipitation was conducted. As the precipitation technique was further advanced at the time it was incorporated into the process, and was accomplished by treating a specially prepared solution with lime.

New Books

Chemical engineering in industry

The manufacturing processes of the various chemical industries can be broken down into two kinds—unit physical operations and unit chemical operations—and this book* attempts to correlate these two concepts as bringing unifying principles into what was formerly a large group of apparently unrelated industries. The main object of this book, however, has been to lay emphasis on chemical engineering, which is the chief factor in chemical process industries. Other objectives include presenting a cross-section of the manufacturing procedures employed by modern chemical industries, largely separated into their unit chemical processes and unit physical operations through the help of flow charts.

Many manufacturing processes based on important chemical changes are also involved, and these operations include data and principles from other branches of science and engineering. The text therefore emphasises not details but broad principles, or a distinguishing characteristic of a certain process or industry. Flow sheets are important in this respect, and are used to present an all-over view of many processes.

Many data are included, on the basis of which a cost estimate can be made, although the book is not primarily concerned with cost determination. As the book was, however, written for the American reader originally, costs are given in dollars.

This second edition has been re-written and brought up to date; flow sheets have been revised, obsolete flow sheets have been omitted and new ones added. A special section, placed as an appendix, consists of problems, which were previously found at the end of each chapter, the place now for detailed references.

**The Chemical Process Industries*, by R. Norris Shreve. 2nd Edition. McGraw-Hill Publishing Co. Ltd., London, 1956. Pp. 1020, inc. index. Illus. 64s.

Organic chemistry

The principles and concepts of modern organic chemistry and the applications of the fundamental science to technology and to biochemistry and medicine are developed in this book,* the third edition of which has recently appeared. Since the second edition appeared, in 1950, many new developments have taken place, among them being the elucidation of structures and total syntheses of important fatty acids, carbohydrates, isoprenoids and antibiotics. Advances in theory have also been important. More mechanisms are included than previously, of both ionic and free radical reactions, and are cited throughout the text as the reactions are encountered. Mechanisms of ionic reactions are further reviewed and extended in an integrated exposition which includes experimental evidence in support of the theory and also instances where present theory is inadequate.

Among the various chapters are some on saturated hydrocarbons (alkanes), ethylenic hydrocarbons (alkynes), petroleum, nitro compounds, sulphonic acids and polynuclear hydrocarbons. Tables and diagrams are included, and there is an author index as well as a subject index.

**Organic Chemistry*, by Louis F. Fieser and Mary Fieser. 3rd Edition. Reinhold Publishing Co., New York; Chapman & Hall Ltd., London, 1956. Pp. vi + 1112, inc. indices. 50s. net.

Fluid flow

Fluid flow is, of course, a vital subject in chemical engineering, and this book* is a compilation of papers read to the third 'Experience in Industry' symposium sponsored jointly by the Philadelphia-Wilmington section of the American Institute of Chemical Engineers and the University of Pennsylvania. All the papers at the meeting dealt with one aspect of the very broad field of fluid flow, *viz.* the flow of liquids in pipelines and pumps and simple applications for gases.

The seven chapters cover the subject from a review of basic problems to problems in design, the selection of components and the operation and maintenance of equipment. The concluding chapter describes trends in research and indicates how the basic principles of fluid flow extend into process design with many unit operations. Illustrations and diagrams are included in the text, and these should prove of help to the younger engineer.

**Fluid Flow in Practice* (J. R. Caddell, editor). Reinhold Publishing Corporation, New York; Chapman & Hall Ltd., London, 1956. Pp. 120. 24s. net.

Electric motors

In this book* an attempt is made to demonstrate how to raise the productivity of both manufacturing plants and individual machines, by reviewing the applications of electric power in a wide range of industries, and indicating the way to make the best use of the electric motor and its associated control gear.

**Electric Motors and Controls*. British Electrical Development Association. Pp. 280, inc. index. 9s.

WHAT'S NEWS about

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

★Plant
★Equipment
★Materials
★Processes

Aluminium jacket for pipes

A new form of aluminium jacketing, *Corrosheath*, is expected to have a number of varied uses for the protection of insulation materials, including the enclosing of steam, hot water, chemical and oil pipes.

The jacketing is made of 0.006-in. gauge aluminium foil fabricated with $\frac{3}{16}$-in. corrugations to provide extra strength. The actual alloy used is aluminium 2S hard tempered (B.S. 1470SK). Generally the jacketing has a glued-on asphaltic moisture barrier comprised of kraft union waterproof paper. This barrier is claimed to prevent any possibility of corrosion where the insulation material is alkaline. However, the jacketing is also supplied plain—without the moisture barrier—for use where the problem of corrosion does not arise.

The material is supplied in 24-in.-wide rolls, 100-ft. long, and may be cut to size on the site. This 2-ft. width is easily handled and fixed by one man who simply cuts the jacketing to the required size, wraps it round the insulated pipe, and secures it with an aluminium strap at each end of the strip. The jacketing may be cut with strong scissors and, in fixing the band, sufficient tension may normally be obtained by hand. The strapping used is supplied in 5-lb. coils, and is $\frac{3}{8}$-in. wide and 0.020-in. thick.

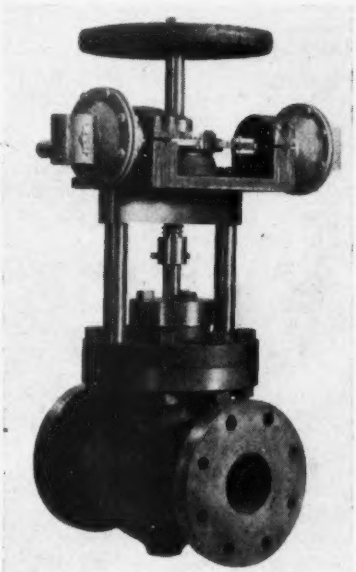
When covering the full length of a pipe, each width of jacketing should overlap to provide complete protection. In this connection the problem of pipework bends is met by using a 3-in.-wide soft-tempered strip aluminium which may be applied like a bandage. **CPE 365**

Chemical pumps

To meet the requirements of the chemical and process industries, there has been developed the *B-N* series of stainless-steel chemical pumps. These are available for outputs of 5 gal./min. up to 200 gal./min. against heads from 10 up to 250 ft. To cover this range of duties only two support frame assemblies are used, but with these two a total of six different hydraulic units can be used. A selection of sealing methods is also available, such as mechanical or double mechanical seals. **CPE 366**

Pneumatic remote control for valves

Standard motorising units are available for the remote control of all types of standard valves. These motorising units can be fitted to valves *in situ* and amongst their many unusual features are extreme simplicity and suitability for incorporation into both simple and complex control systems. The equipment is suitable for operation from 3 to 15 p.s.i. control signals and is proving especially suitable for group process valve control.



Remote valve control.

A recent development in valve control has been the design of a small, compact control panel which, the makers state, provides the operator with the same flexibility and sensitivity of valve adjustment as can be achieved by manual control of the valve hand-wheel. The panel provides valve adjustment at both high and low speed together with step-by-step movement and position indication. The simple standard motorising unit is fitted to the valve and connected to this control panel by only four small-bore air lines. A single valve may be controlled from one or more of these panels arranged in parallel or with a master and secondary panels. The lever-type control provides high- or low-speed operation in either direction, the low speed being adjustable by the operator on the panel face. The push buttons provide step-by-step adjustment in 36, 58, 76 or 100 positive steps per revolution of the valve hand-wheel. For each push of the button one step only is taken however long the button is depressed. A small stainless-steel transmitter unit fitted to the valve provides mechanical position there and transmits it pneumatically to the control station or

C.P.E.'S MONTHLY REPORT AND READER SERVICE

stations by a single small-bore pipe where it is indicated on edgewise or dial-type indicators. An important feature of this position indicator, the makers point out, is that its accuracy is unaffected by variations in the air supply pressure.

An unusual feature of the control panel is the special dual-purpose lever control switch which has a spring-loaded head, the depression of which in the operational position alters the speed from the adjustable slow speed to full speed. This switch has many other uses in connection with the motorising units and is frequently used to provide a single control for interlocked normal or step-by-step operation. For this application, movement of the lever in either direction produces a single step, unless the head is depressed in the neutral 'off' position when movement of the lever in either direction sets the motorising unit into normal continuous operation. As the head must be depressed from the neutral position it prevents any danger of accidentally putting the unit into normal operation when a single-step adjustment is required.

It is claimed that the motorising units ensure tight valve closure, as they are designed to stall against the valve seats at any desired torque selected by adjustment of the applied air pressure. The stalling torque of the units is proportional to the applied air pressure, toothwheel size and motor combination. Differential power can be provided to ensure that valves on which there is a tendency to wedge when closed tight can always be unseated and provision can be made to prevent similar difficulties arising at the fully open position.

Another control arrangement is for open/close valve control with end point indication and assurance of tight closure from a control panel comprising only two push buttons, one for each direction of travel. When either push button is pressed the head remains depressed until the valve has stalled against its seat, which causes the button to fly out again, cutting off the air supply and indicating that the end position has been reached.

CPE 367

Filters for water purification

A firm which manufactures water treatment and filtration equipment suitable for many industrial requirements is offering units in which the filtering medium is in the form of hollow candles of various sizes made of kieselguhr. The candles are completely closed at one end and the other end is fitted into a metal or porcelain mount. The water passes through the walls from outside to the inside, leaving all impurities on the external surface and then out through the small aperture of the mount.

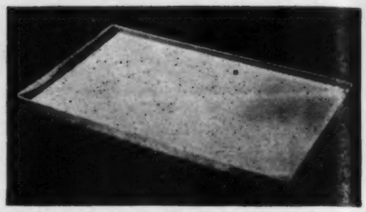
During the last few years they have been carrying out research in an endeavour to find a practical method whereby the normal bacteriological purification effected by the candle could be reinforced and the sterility of the candle itself ensured by the incorporation during manufacture of a self-sterilising agent. This improvement is now offered under the registered trade mark *Sterasyl.*

Among the advantages claimed for the new candle is that the presence of the ionic material used in its manufacture prevents the growth of organisms in the pores of the candles (the ions penetrate the wall cells of the bacteria and inhibit their supply of nourishment) so that it remains sterile for an indefinite period, while continuing to produce filtrate of the highest bacteriological purity.

The candles, too, will last for a long time without renewal and for cleaning purposes all that is necessary is to wash them occasionally with a soft brush in clean water; no soap or detergent should be used. They are obtainable in the usual sizes for all types of gravity and pressure water filters from the small stoneware or enamelled iron domestic models to the large supply pressure filters used by brewers, mineral water manufacturers, etc., where a water of high bacteriological purity is required. **CPE 368**

Analytical reagents

A British company is now offering a range of laboratory chemicals among which are many products—particularly analytical reagents—which are either unobtainable in Britain or at least only obtainable in a relatively impure state. Certain groups of substances are offered for particular purposes, *i.e.* for soil analysis, chromatography, biological staining, etc. Of particular interest are the *Titrisol* ampoules of volumetric solution, which are of special design in that they may be opened entirely without risk of spilling and can be flushed with distilled water so that the entire charge of the concentrated liquid is washed into the volumetric flask. **CPE 369**



Drying tray in plastic and glass fibre.

Chemical drying trays

Chemical drying trays, made with *Cellobond* polyester resin and glass fibre, use a special chemical-resistant filler with the resin. Rigidity is achieved by moulding a cruciform member into the bottom of the tray.

In use, the tray is loaded with 30 to 40 lb. of wet chemical paste, which is then dried in an oven at a temperature of up to 250°F.

The manufacturing specification for the chemical requires that the maximum metallic contamination must not be greater than 1 or 2 p.p.m. With enamelled iron trays formerly employed, this specification was difficult to meet. It is claimed, however, that the new type of tray has successfully overcome this problem. **CPE 370**

Jaw crusher

A jaw crusher that is being marketed has an all-up weight of only 15,000 lb. and a rated capacity of up to 89 tons/hr. at a 4-in. jaw setting, depending on material. The feed opening is 30 × 15 in., and is designed to accept a feed of 11- to 12-in. lumps.

A light, strong pitman and relatively flat toggles are designed to give great leverage combined with low bearing pressures. Flood lubrication is claimed to permit cool running at 350 to 385 crushing strokes/min.

An overload safety device is built into the hub, giving protection against tramp iron. **CPE 371**

MOBILE SERVICE FOR *p*H EQUIPMENT

A fleet of mobile service units has been introduced by a British manufacturer of industrial *p*H equipment. This service, which its operators claim to be unique, ensures that every customer of the company is regularly visited by a skilled engineer to ensure that the plant is working at its highest efficiency. **CPE 372**

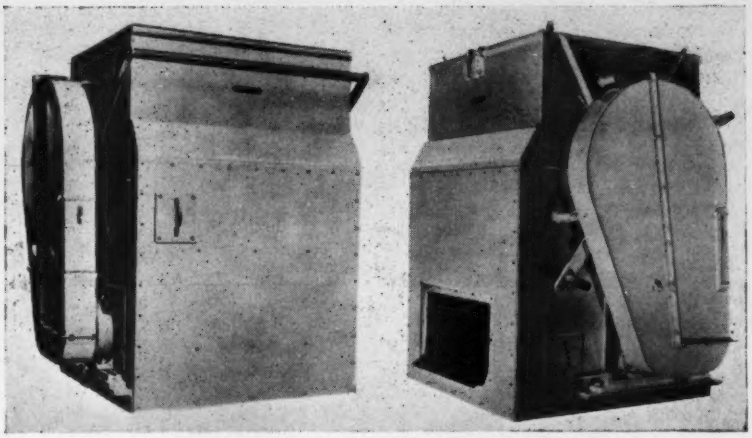
Polythene bag feeding machine

A new polythene bag opening and feeding machine will fill bags from a minimum size of $2\frac{1}{4}$ in. $\times$ $5\frac{1}{4}$ in. to a maximum size of $5\frac{1}{2}$ in. $\times$ 13 in. It was designed specifically for polythene bags, but the opening and holding unit has been found to be sufficiently delicate to operate successfully with paper and parchment. Bags must be of the gusseted type.

The initial sequence of operation of the compact unit is as follows: bag separation by suction; positive separation of individual bag by a hollow blade; mechanical transfer from suctional section so that the bags are carried out of powder reach of the suction gear.

The machine is controlled by the speed of the weighing unit, but the makers state that up to 20 bags/min. can be filled. The magazine capacity is approximately 500 bags and it can be refilled without halting the opening and feeding operation.

When a bag has been mechanically transferred to the filling position a no-bag detector carries it to the weighing operation. The bag must wait until it is actually filled before it can be released. Failure to pick up a bag will stop the whole sequence of packaging, give the operator an opportunity to attend to the fault and thereby prevent the plant from discharging into badly filled or damaged bags. It is believed that this will enable one operator to supervise several machines without spillage or waste. **CPE 373**



Two views of the new soap amalgamator.

Soap amalgamator

A new soap amalgamator now being produced by a British engineering firm is of the bottom discharging type. The discharge gate is operated from a control bar which runs the whole length of the machine and which is therefore very easily accessible to the operator.

The whole of the mechanism, including a 5-h.p. a.c. geared motor, starter and heavy-duty chain drive, is enclosed in light sheet steel panels. The mixing chamber is of welded mild-steel construction and is lined with stainless steel. Mixing blades and shaft are of nickel-plated steel and are mounted on bearings isolated from the chamber.

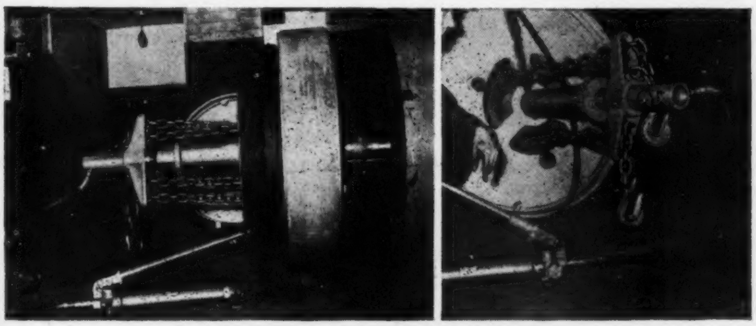
The feed doors incorporate large perspex observation panels. When shut, they rest on micro switches which prevent the mixing blades from rotating when the doors are opened.

The mixing chamber holds 2 cwt. of soap mixture at a density of 16 lb./cu.ft. **CPE 375**

Data transmission

It is announced that a new Anglo-American company has been formed for the production of precision synchros, servo motors, resolvers and tachometer generators for use in computers, radar sweep circuits, phase shifters and accurate data transmission systems. The synchros range from size 10 to size 31 and include all international size standards. There are units for every purpose including transmitters, control transformers, receivers and differential units and as special-purpose devices can be used for converting three-phase data into two-phase data.

Resolvers, or computing synchros, are available in sizes 10 to 23 in an exceptionally wide variety of types covering applications from coarse $\pm$ 0.2% to precision $\pm$ 0.05%. Servo motors are available for 400 or 60 cycles as standards and for 50 cycles. These high torque to inertia servos range from sizes 10 to 23 with torques of 0.1 in. -oz. to 7.5 in. -oz. and tachometer generators are available for 60- and 400-cycle excitation with linearity of 0.1%. Zero speed voltages are held to 5 mv. in phase, 5 mv. quadrature and 15 mv. third harmonic.



QUICK PULLEY REMOVAL

These photographs were taken at Rapid Magnetic Machines Ltd., Birmingham. They show how a pulley 42 in. $\times$ 45 in. fitted to an electro-magnetic separator is easily removed by Porto-Power *hydraulic equipment. It does the job in less than 1 hr., where formerly it took 12 hr., and has been known to take up to eight days. A 20-short-ton hydraulic ram, RC 251, is coupled to a chain pull plate, and two chains are used, each firmly wrapped around the spokes of the pulley. (A short ton is 2,000 lb.)* **CPE 374**

These units will be available in a very wide range of sizes and outputs. Extensive use in the U.S.A. has proved their efficiency and reliability and the units will now be freely available in Europe and the sterling area generally for their many and varied applications.
CPE 376

Electronic controls

A British firm have become the manufacturing licensee and sole agents in the British Commonwealth (except Canada) and Europe for the complete range of *Autronic* control and transmission equipment.

This miniaturised, all-electronic equipment provides a new and revolutionary approach to process and power instrumentation. Transmission lags are completely eliminated from control circuits by employing electronic means for both transmission of measurement data to the control centre and transmission of control impulses back to the processing unit. It is stated that the system is extremely flexible and can operate with a.c., d.c. or motion inputs, as well as the conventional primary measuring element inputs.
CPE 377

Barrel loader

A barrel and box loader is available which is claimed to have the following advantages:

Lightness. The loader is easily moved by one person, by tipping it on its two rubber-tyred wheels like a wheel-barrow.

Speed. The duration of loading or unloading is approximately 15 sec.

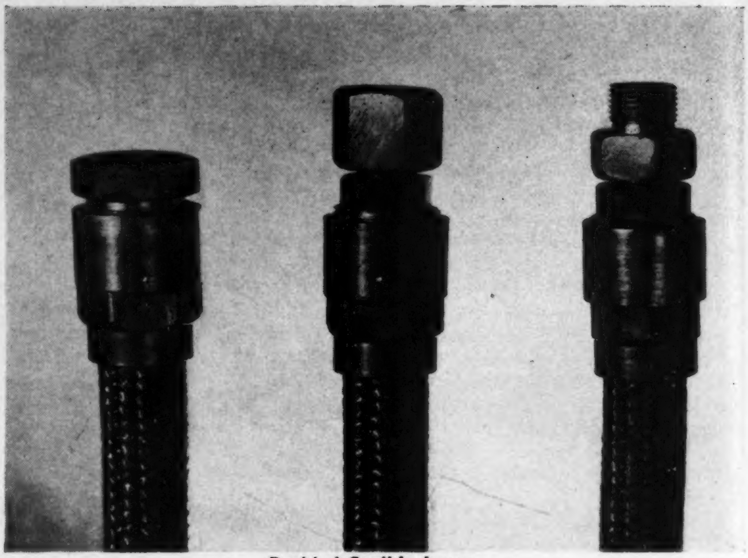
Ease of operation. The barrels or boxes roll or slide off the loader under their own weight. When boxes are being handled a platform on rollers is supplied with the loader.

Safety. Both controls are grouped on the same side of the machine so that the operator is well clear of the line of movement of the barrels or boxes when loading or unloading.

Adaptability. By means of a simple adjustment the level of loading or unloading can vary from 3 ft. to 6 ft. 3 in.

Simplicity. The hydraulic regulation by means of a single lever gives an easy and accurate control of the speed of loading.

Lifting capacity is 800 lb., while electro-hydraulic drive is provided by oil through a double-helical gear pump and a 2-h.p. electric motor running from an a.c. supply. The unit is fitted with a direct-on-line push button starter.
CPE 378



Braided flexible hoses.

Flexible hose

Of particular interest to users and processors of steam, air, water, gases, viscous oils and chemicals is a new type of flexible hose. This hose has no joints at all and is manufactured from solid-drawn tubing and thus, the makers point out, the fear of leaks is completely minimised and the risk of contamination overcome. Although the tube is of metal, extreme flexibility is still prevalent. It is stated that the Ministry of Works have carried out vacuum tests with great success.

Formed in spiral (helical) corrugations, it is manufactured with three degrees of pitch, namely very fine, fine and standard pitch. The metal tubes used in manufacture contain 85% copper and 15% zinc and bores of ⅛ to 6 in. diameter are available.

For normal use fine corrugations are generally found to be satisfactory and, where lengths of over 5 ft. can be accommodated, the use of standard corrugations can be adopted.

The choice of the pitch of tube is dependent upon application and pressure; thus for plastic or rubber moulding presses where vertical movement has to be accommodated or for the removal of vibration the use of fine corrugations are recommended.

For very high pressures bronze or galvanised steel high-tensile wire is multi-plaited to form a sheath on the outside of the tube which, when attached to the end fitting, prevents stretching of the tube. Tube for very high pressures is multi-braided and under these conditions the following pressures have been achieved:

Bore	*p.s.i.*
¼ in.	6,000
⅜ in.	6,000
½ in.	4,800
¾ in.	4,000

A new type of braid has been developed on which longitudinal lines are of special use for indicating twist or distortion on the tube when fitting.

Two new types of end fittings have also been developed recently:

(1) A re-usable union of the compression type, easily fitted where the tube is held in a ferrule and the body. The union front which makes the seal between the tube and reinforced washer has a clamping action. No solder or brazing is used in the fitting of the tube. Special washers to suit the various media can be supplied to meet particular requirements. Instead of a union front, fixed ends can be fitted. This type of union is a boon to manufacturers where the tube can be cut back and shortened by a few inches and the union refitted.

(2) Another union is very similar to that described above, but has a metal-to-metal seat.
CPE 379

Descaling

A range of equipment designed for descaling boilers, economisers or other tubular installations includes two main types: those incorporating the use of a flexible drive, driven by either compressed air or an electric motor; and

the air-turbine-type tube cleaners which are inserted into the tubes themselves.

This latter type is said to be of particular interest to petroleum refineries, power stations, chemical plants or any installation where spark risk must be avoided. **CPE 380**

PORTABLE BAGGING AID CUTS HANDLING AND STORAGE COSTS

Users of jute and multi-wall paper sacks will be interested to learn of an American machine now being distributed in the United Kingdom which, by smoothing and flattening filled sacks, not only expels surplus air from each sack, but also eliminates wasteful air space in the total stack and speeds up stacking rates.

Filled sacks are loaded onto a conveyor belt and pass beneath a pressure roll, with easily adjustable pressure and clearance of 7 to 12 in. The machine is powered by a 1-h.p. enclosed electric motor (60 cycle, three phase, 220 v.) operated by a manual push-button starter. The motor connects directly with an oil-bath worm-gear speed reducer, which in turn drives the pressure roll and the conveyor head roll through a quiet roll chain drive. The pressure roll, conveyor roll and idler are mounted on ball bearings and the tail roll is adjustable for belt tension.

Overall dimensions of the standard model are 32 in. wide, 44 in. high and 82 in. long. The belt, which is 20 in. wide, moves at 32 ft./min. This model flattens bags up to 100 lb. in weight at a rate of 300 to 500/hr. For flattening bags from 125 to 250 lb. there is a *Jumbo* model, similar to the standard, but with a 30-in. belt and overall dimensions 42 in. wide × 54 in. high × 96 in. long.

For convenience in loading hand trucks, flatteners which operate on an incline are available. The bags are discharged 3 to 4 ft. above ground level. A special quick-acting pressure roll adjustment is available for use when bag thickeners are varied frequently.

All models are completely portable on swivel casters. General construction is steel throughout. The main frame is welded structural steel to ensure rigidity. **CPE 381**

Chemical- and rust-resisting paints

Here is a paint intended for use where chemical conditions are such that normal paint films are soon destroyed. *Antykem*, as it is called, is claimed to be unaffected in the presence of solutions of most acids and alkalis, including the following: acids—sulphuric, hydrochloric, nitric, phosphoric, boric; alkalis—sodium hydroxide, potassium hydroxide, ammonium salts, chlorine, sulphur dioxide, hydrogen sulphide, ammonia, etc. It is also insoluble in petrol, benzene, mineral oil, glycerine and water.

Another product of the same firm is *Faroprime* red oxide-zinc chromate primer, formulated as a primer for aluminium and aluminium alloys, and suitable also for use on iron and steel work. It provides an efficient anti-corrosive flexible film, it is claimed, possessing good rust-inhibitive and adhesive properties. It is made ready for use. **CPE 382**

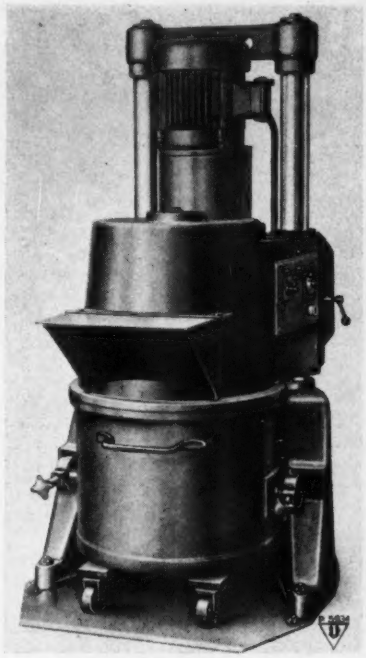
Mechanical pestle and mortar

An entirely new electrically driven pestle and mortar grinder for the fine grinding of samples should be of particular interest to laboratories.

According to the makers, the outstanding feature of the machine is its rapid and efficient action. Driven by a totally enclosed fractional-h.p. motor and worm reduction unit, both pestle and mortar rotate in opposite directions, the former at 96 r.p.m. and the latter at 32 r.p.m. The mortar is fitted into a hardwood holder which rests freely on the sponge-rubber bed of the carrier. The mortar thereby assumes an inclination to the horizontal plane under the pestle, giving even grinding pressure and concentrating the sample under the pestle, the centre-line of which is offset to that of the mortar. The pestle is instantly retractable for withdrawal of the ground sample.

In the standard machine the pestle and mortar are of polished agate, but alternative materials are available. **CPE 383**

Pestle and mortar grinder.



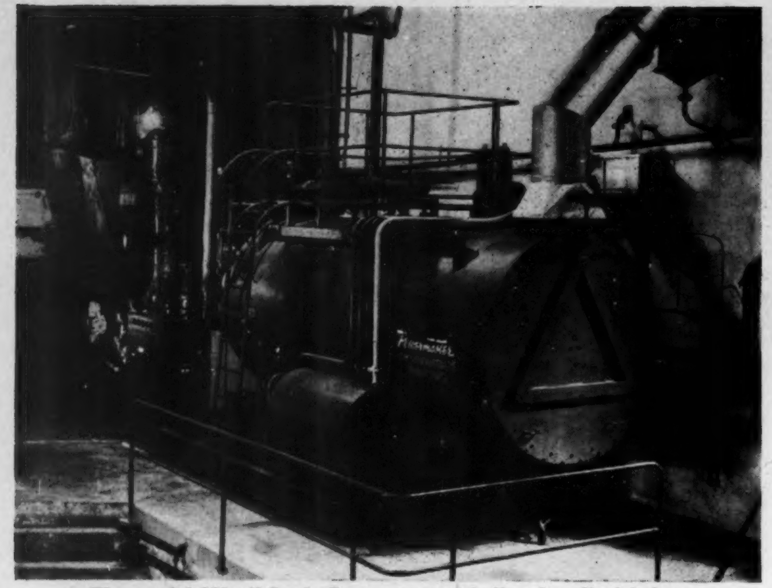
PLANETARY MIXER

This planetary mixer is stated to be suitable for a wide range of materials, including stiff pastes. A feature to be noted is the stability provided by the two supporting columns and a portion which half surrounds the container in which mixing takes place. **CPE 384**

Pumps for corrosives

A company who have specialised in the pumping of acids and other corrosive liquids for many years are marketing compressed-air-operated glandless acid pumps, both vertical and horizontal. For handling small quantities, a hand-operated, semi-rotary pump and motor-driven, positive rotary pumps are available.

The same company deal with process heating by coal, electricity, gas or oil, describing six different types of heating systems. **CPE 385**



The model 200 oil-fired 'Powermaster' boiler described below.

Packaged boiler

A packaged boiler of the super-economic, horizontal-fire-tube type, with three-pass gas travel, is available in a series of 17 models giving steam outputs from 517 to 17,250 lb./hr. According to the manufacturers, practical experience has shown that this maximum steam output represents the largest practicable size of self-contained boiler which can be supplied owing to mechanical and constructional limitations. Where steam outputs in excess of approximately 18,000 lb./hr. are required, it is general practice to install several boilers.

A model 200 oil-fired *Powermaster* boiler was recently supplied to the Bradford works of Messrs. Sandoz Products Ltd., which specialise in the production of dyes, bleaches, detergents and similar materials for textile application. It is claimed that the new boiler easily caters for any violent fluctuations in steam demand, since the firing system is subject to fully modulating control. This means that from 20 to 100% boiler capacity the correct fuel/air ratios are maintained, giving consistent operating efficiencies of over 80%. The average flue gas CO_2 content is stated to be 12.5% with an attendant stack temperature of 395°F. This modulation control is governed by a pressure switch in the case of steam-raising boilers or by means of a thermostat for water-heating units. The adjustable cam positions for the fuel valve and air shutter are pre-set in the manufacturers' works where a comprehensive fire test is carried out on each boiler before despatch to the customer. Since the boiler is entirely self-contained, it is sent direct to the customer immediately after the final test, and all that is required in the way of installation is for connections to be made to the fuel, water, steam and electricity lines, the boiler itself only needing a level concrete floor to stand on, with provision for drainage.

The makers claim that the model 200 is capable of a maximum steam output of 6,900 lb./hr. F. & A. 212°F., yet only occupies a floor space 18 ft. 3 in. long × 8 ft. wide. At the present moment the steam demand varies between 2,000 and 5,000 lb./hr., the average figure being approximately 3,000 lb./hr. on a pressure of 100 p.s.i.

Apart from the process steam in the works and laboratories, the boiler caters for space heating in the offices, stores, laboratories and canteen where the pressure is reduced to 10 and 15 p.s.i. There are also hot showers, etc., provided which are supplied through a calorifier. The feed water to the boiler comprises approximately 60% condense return, the rest of the make-up being from the mains.

All types of fuel oil may be used for firing this range of boilers, from 200 up to 3,500 sec. viscosity Redwood No. 1, and even coal-tar fuel may be burned. The boiler illustrated fires on 950 sec. viscosity oil which is stored in five tanks with a total content of 5,000 gal. In these, the oil is maintained by means of steam-heated coils at a temperature of 90 to 100°F., while the built-in preheater on the boiler itself raises the temperature still further to the optimum for atomisation, which is 150°F. One of the storage tanks is fitted with an electric heating system, the oil from here being used for initial starting after a shut-down of any appreciable period. **CPE 386**

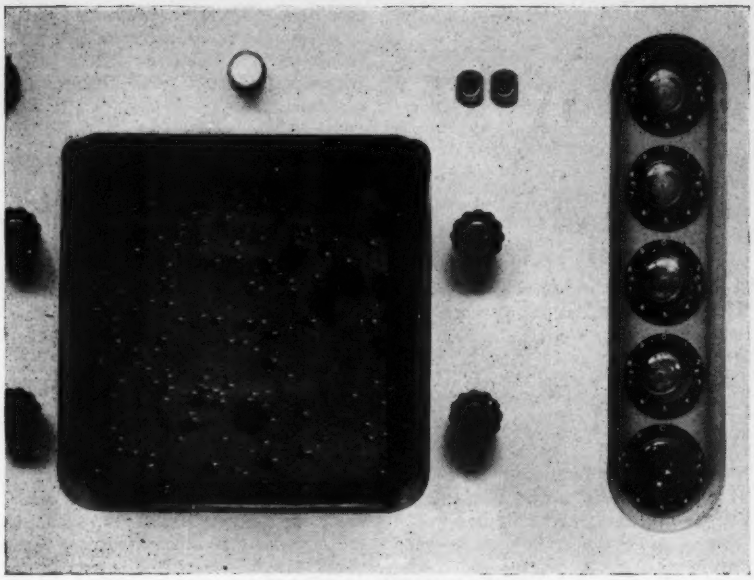
DRAIN COCKS FOR USE IN FILTER PRESSES

Immediately after the last war, ethoxylene or epoxy resins were developed in Switzerland and the use of these materials in the chemical industry is assuming greater importance every year. The resins can be worked either as cold setting or in a hot casting process, according to the particular types of resins and appropriate hardeners used. The basic resins themselves are marketed under trade names, e.g. Araldite, *but to them, during hot casting, filler can be added to produce various characteristics in the finished product.*

A particular formula has been developed by a British firm of electrical engineers for use in producing drain cocks for filter presses in the chemical industry. It displays the excellent chemical-resistant properties of the epoxy resins, whilst a filling agent has made it tougher to resist the rough usage on the shop floor, together with excellent self-lubricating properties for the moving parts.

The illustration shows some of the range of taps which have already been developed for the replacement of lignum vitae. It is claimed that the epoxy products have a much longer life, not only in chemical resistance but also obviating moisture absorption and freedom from consequent splitting.

CPE 387



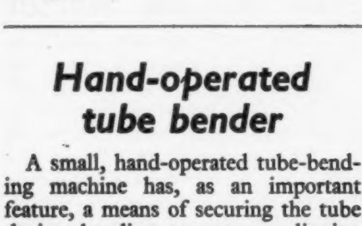
PARTICLE ANALYSER

Counting and sizing of microscopic particles can be carried out in a matter of seconds with this film-scanning particle analyser. Here, a picture of the pigment dispersion can be seen on the screen of the cathode ray tube. As a particle is counted, its image is tagged with a bright fleck of light and the number of particles is displayed on the right. **CPE 387**

Hand-operated tube bender

A small, hand-operated tube-bending machine has, as an important feature, a means of securing the tube during bending to prevent slipping and at the same time gripping the very minimum of tube. The result permits very close-set bends to be achieved for bending tubes to fit around piers and projections. The makers point out that the snug fit ensures considerable economies in material and at the same time provides a very neat and tidy result.

The bender is quite versatile and is capable of bending light-gauge ferrous and non-ferrous tubes of up to 1½-in. diameter and steam and gas tube up to ¾ in. n.b.



Tube-bending machine.

The forming of tube is by compression bending over an accurately machined centre-forming die and slipper. The throat ratio of the bend is equal to 3 $\times$ diameter, and bends of up to 180° can be produced cold and unloaded and free from flattening and wrinkling. Change-over from right to left in bending direction can be carried out in a matter of seconds and, when the bending arm is returned to its pre-bending position, a device automatically ensures the correct angle of lead prior to the next bend. The base of the bender is circular and carries four lugs suitable for universal mounting on bench, vice or bipod. **CPE 388**

Transmission belting

A new kind of frictioned rubber and canvas belting is available for use as a general-purpose transmission belt. Known as *Maxgrip*, it is claimed to maintain a tenacious grip on the pulley throughout the life of the belt, at the same time taking its full share of the tension.

This driving ply is woven from patented yarn, in which the cotton and rubber latex are mingled under vacuum and spun together, this process resulting in each cotton fibre being coated with rubber before being twisted and woven. The driving play, then, consists of 50% each of cotton and rubber throughout.

CPE 389

Plastic coatings for metals

A dipping process has been developed, based on ' fluidised ' polymers of various plastics to produce corrosion-resisting and electrically insulating plastic linings on metal articles. Whilst the process is suitable for all lining and coating applications, it is particularly suitable for articles which on account of their complex form cannot be lined by a spray application or where the latter would be uneconomical. For the ' fluidisation ' of the various polymers used, a special apparatus is necessary.

The apparatus consists of a container with lid, a sieve base and an air or nitrogen connection with control valve. The sieve base is made from a ceramic material with fine pores. The sieve base is impermeable to the powder in the container. The air (or preferably nitrogen to prevent oxidation) which flows to the sieve base penetrates, without great loss of pressure, the ceramic base and sets the overlying plastic powder above it into motion.

The circular movement of the plastic powder represents a state which is similar to a liquid and it is therefore possible to achieve complete and uniform covering of even articles of complex shape. This overcomes the disadvantage of conventional stationary powder dipping where it is difficult to coat articles of complex shape or to obtain a really uniform coating on any article.

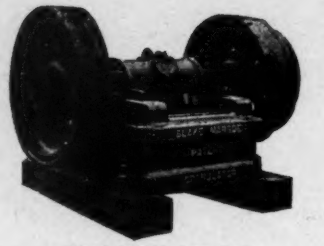
Specially prepared polymers are used for the ' fluidisation ' process.

Articles may be prepared for treatment by degreasing and a rough-sand blasting to improve mechanical adhesion. Small articles are very often completely lined in such a manner that in the process of cooling the plastic lining shrinks on to the article and binds tightly to its surface. In such cases sand blasting is unnecessary. All articles should be degreased before immersion by any of the usual methods, *i.e.* alkali or solvent degreasing. In the case of plating racks it is usually possible to avoid sand blasting, but this causes a slight reduction in adhesive power of the coating.

The makers claim the advantages of the process to be a short working

cycle, no loss of plastic material, positive and continuous lining and easy adjustment of thickness of lining. Complete lining of complex shapes such as narrow channels or deep hollows and drillings and, in addition, stronger adhesion than by normal powder lining can be achieved, it is claimed. It is further stated that there is almost complete prevention of oxidation if nitrogen is used, while only simple equipment is necessary, *i.e.* heating burner (welding, blow lamp, etc.) and holding devices (tongs, pliers, etc.).

Suitable for lining with the *Whirl Sinter* process are: plating racks, anodising jigs, small exhaust fans, pump impellers and cases, sieves and sieve frames, pipe spirals, band wheels, switches and other electrical armatures, needle frames, small containers and buckets, lids, safety coverings, sleeves, sleeve connections and many other parts. **CPE 390**



GRANULATOR

An all-steel roller-bearing granulator which can be used for the production of materials below ¾ in. finished sizes. It is built in three sizes for throughputs from 6 to 15 tons/hr. **CPE 392**

Flexible hose for liquid oxygen

A new flexible hose for conveying liquid oxygen, which is claimed to have a number of important advantages over the metallic flexibles used previously, has been produced experimentally. Liquid oxygen has a temperature of –183°C. and is therefore usually transported in vacuum-insulated, double-walled, spherical containers. An increase in temperature above –183°C. results in the liquid 'boiling off'—1 cu. ft. of liquid yielding 848 cu. ft. of free oxygen at 15.6°C.

Metallic flexibles are normally used for liquid oxygen, but these often provide heat feed-back into the carefully insulated container which, in turn, causes an increase in the boiling off. The new hose, which is made on a composite principle, is claimed to obviate this difficulty by acting as a heat brake. In addition it is claimed to have a far greater degree of flexibility at low temperatures—the 4-in.-bore size has a bend radius of 3 ft.—and to be the only economic way of conveying liquid oxygen at high pressures. It is stated that the new hose has already been in constant use for over a year and is still giving satisfactory service. It is also claimed to be satisfactory for conveying liquid nitrogen (–194°C.).

The hose consists of an inner wire spiral of 12-gauge stainless steel, lappings of square-woven 10 to 12 oz. Terylene fabric, layers of terylene film (*Melinex*), further layers of Terylene fabric and an outer wire helix also of 12-gauge stainless steel. The number of layers of film and fabric used in the hose make-up depends on the working pressure required, but the wall thickness would be at least ¼ in. for a low-pressure hose. For working pressures over 500 p.s.i. the hose would have an additional outer braiding of stainless steel.

The liquid oxygen hose has been produced experimentally in lengths of up to 20 ft. and in bore sizes up to 4 in. i.d., but development work is still being carried out on bore sizes of up to 8 in. i.d. **CPE 391**

Strip chart recorder

A strip chart potentiometer recorder with a pen speed of ¼ sec. (full-scale travel) has recently been introduced.

The electronic null-balance servo measuring system incorporates a newly designed plug-in amplifier with a high input impedance and output power. The latter is approximately eight times that of the amplifier used in conventional recorders.

Amplifier output drives a new type of balancing motor having a no-load speed of 1,650 r.p.m. The design refinements of the motor, amplifier and slidewire assembly produce a pen speed giving full 11-in. scale travel in only ¼ sec. A tachometer circuit provides damping which is strictly a function of pen speed, and is adjustable by means of a rheostat.

The ¼-sec. recorder is designed to meet the demands of scientists and development engineers who need to record rapidly changing variables. It is stated that typical applications are found in guided-missile development where rocket and rocket-fuel performance are studied; the determination of instantaneous rates of flow as met in jet-engine development; analogue computer output recording and spectrographic analysis where high scanning rates and small changes are common. **CPE 393**

Floors with resistance to acids, alkalis, etc.

The outstanding characteristic of vinyl tiles is their resistance to acids, alkalis, oils, greases, etc. Only solvents of the ketone group affect them, the PVC being softened if left in contact over a period of time.

Coving may be formed by carrying the tiles up the wall, providing that the tile is fully supported. Decorative strips in plain or mottled colours are available in 1- to 6-in. strips.

Tiles may be laid direct on to concrete screeds free from rising damp, using cement and latex mixes. New floors should contain a damp-proof course or sandwich membrane. The use of surface treatments only is not recommended, though in many cases they will prove satisfactory. **CPE 394**

New silicate mortar

A new type of corrosion-proof mortar, *Corlok*, has made its appearance in the United States as the latest development in silicate bonding material. Especially designed for the installation and maintenance of stack linings and acid tanks, this mortar is based on a precisely adjusted potassium silicate, is essentially free from sodium silicate or other sodium compounds and contains no fluoride setting agent. The manufacturers state that it withstands strong oxidising acids, nitric, chromic and concentrated sulphuric, and is resistant to sulphation and highly concentrated acids at temperatures up to 1,900°F. for longer periods than any other acid-proof silicate cement. It is claimed that the product is non-corrosive to metals and will not react with lead or chrome-nickel alloys.

Two materials are used to prepare the *Corlock* mortar—a potassium silicate solution which is entirely new, and a powder packed in 100-lb. polythene-lined bags, dated to ensure best results within a specified time limit.

This special-type mortar can be used for laying acid-proof brick or tile in combustion gas condensation and sulphuric acid production services; for structures in which maximum bond strength is essential, and where improved impermeability is desired. **CPE 395**

Depreciation and Maintenance of Chemical Plant

I—Depreciation as a Factor in Chemical Engineering Costs

By S. Howard Withey, F.COMM.A.

MOST of the leading large-scale makers of pharmaceuticals, paints, soaps, cosmetics and polishes, etc., recognise that the attainment of the best results with plant depends to a large extent on the degree of co-operation that exists between suppliers and users, also on the nature and variety of the services which are made available for carrying out essential repairs and effecting adjustments. Chemical plant may be exceptionally dependable and eminently suitable for specific processes, but unless there is a well-organised spares and maintenance service the quality of the products and the costs of production may be adversely affected. Many of the units and groups of plant employed in food production are extremely robust and can be readily dismantled for cleaning and are easily reassembled, and many years of successful experience now enables many plant suppliers to pursue an adequate maintenancy policy, in conjunction, in some instances, with the periodical inspection of individual layouts.

On the advice of the suppliers, some users of chemical plant have allotted each machine or section of productive equipment a nominal period of service or useful life and, while some units and groups may have to be replaced long before they have lost their market value, it would be fallacious to suggest that replacement is essential simply because the allotted period has been achieved. Finishes combining outstanding physical properties—such as excellent adhesion, flexibility and toughness—and improved chemical resistance now provide an effective safeguard against corrosion and, where there is an element of scouring, linings will often resist abrasion. The constant lubrication of moving parts and a careful avoidance of overstrain are the means whereby some productive equipment can be usefully and profitably employed over extended periods.

Tackling the depreciation problem

Before the impact of inflationary pressure, British users of chemical plant were able to make provision on a generous scale for the unavoidable shrinkage in the capital value of their productive installations. However, an analysis of the audited accounts of a representative cross-section of industrial companies shows that, owing to the steep rise in replacement costs, it is difficult for them to build up adequate reserves for the renewal of fixed assets. Some firms have been compelled to defer consideration of the problem of depreciation and, consequently, the valuations which have been placed on certain groups and sections of plant do not always bear any direct relation to the amount of unrecovered investment in respect of which the proprietors expect, sooner or later, to be reimbursed.

The efficiency and economy of machines of varying capacities and sizes are the result of years of experiment and research, and the requirements of labour and the rates of depreciation and operation are being constantly investigated by surveys. Engineers are constantly designing plant calculated to reduce production costs, and new and improved methods of handling have now been devised, with the result that some producers are now reaching the stage where the equipment cannot be employed without loss of output in competition with other producers. The magnitude of the amount of capital now invested in chemical plant and ancillary equipment renders it imperative that the losses arising from the inevitable decline in the capital value of fixed assets should be subjected to more scientific treatment in books and accounts.

Methods of compiling depreciation figures

There are, of course, several methods of arriving at the figures to be shown under the heading of depreciation.

For example, an equal proportion of the first or original capital cost of acquiring and installing machines and plant, including the transport charges and any foundation expenses, may be written off each year and transferred to depreciation account in such a way that at the termination of a definite period the value standing in the user's books will be reduced to nil or a purely nominal figure. This is usually referred to as the 'straightline' method and may be applied when the annual cost of repairing, cleaning, overhauling and adjusting the various units of plant is not expected to vary materially during the period of service or useful life. Expenditure can often be saved by consulting supply engineers in the early stages of new projects, but when upkeep and maintenance are expanding, or seem likely to grow, it is usually advisable to apply the 'percentage' method of computation and accounting whereby the outstanding debit balance of the asset account is subjected to annual percentage deductions at a fixed rate and in such a way that the progressive decline in the annual charge for depreciation, based on the reduced book value, will provide the margin required to cover the expanding upkeep costs.

Maintenance costs

The cost of maintaining chemical plant varies enormously as between one industry and another and also as between one period and another. There is now a definite downward tendency, however, and this is due almost entirely to research and the wider application of scientific methods to industrial processes. De-scaling systems help to maintain production by a substantial reduction of shut-down time and an avoidance of extensive dismantling; the cleaning of coppers is materially facilitated by modern fittings and their construction allows full access to all parts; units of filtration plant and fittings are usually polished through the bore and externally threaded; bottle cleaners, at low initial cost and with no very complicated mechanical features, occupy a minimum of space and ensure low power, water and steam consumption; tanks for bulk and hygienic transport now embody systems of suspension that insulate against shocks and distortion and have a much longer service life; and many conveyor installations eliminate costly handling operations and greatly increase storage capacity.

By estimating the cost of upkeep over a number of years and allocating a proportion against each financial or operating period, it is possible to avoid any material fluctuations in the annual charge for plant maintenance. In this connection, some managements add the capital value of the assets to the total upkeep cost, then divide by the number of years during which the plant is expected to remain in commission in order to arrive at a fixed figure for inclusion in each year's accounts and costings, the expenditure actually incurred on repairs and renewals being charged against a reserve which has been built up to provide for such a contingency. This reserve, however, would have to be fed from time to time by means of appropriations made from disposable profits, and care should be exercised to distinguish between the many daily adjustments of a relatively trivial nature and the really big maintenance jobs.

While the cost of minor repairs can usually be charged against standing orders, it may be advisable to incorporate the more costly repairs in specific costings. Some units of plant only need regeneration or a flushing with acid or alkali, and pumps are now designed to give high volumetric efficiencies regardless of widely different temperatures and viscosities.

Recording expenditure on plant

Sums expended on boilers, kettles, fillers and regulators, etc., are sometimes posted direct from a cash book to the debit side of an appropriate impersonal account kept in the user's private or general ledger, whereas capital outlay in the form of automatic machines, trucks and road transport vehicles is usually shown in a separate section of the purchases journal, the items being collected in the form of monthly or other periodical totals for ledger posting purposes by using a type of book ruled with several columns or sections to facilitate a systematic classification under specific headings.

In addition to these records it is advisable to maintain a complete inventory of plant divided into sections corresponding with the different types, specifications and capacities, each entry giving the date shown on the invoice or other debiting document, the name of the maker or supplier and a sufficiently detailed description to enable each unit of plant to be readily identified. Such details are of considerable value and utility to the management and staff and simplify matters at audit time when depreciation has to be computed and statements drafted exhibiting the financial position.

In some instances interest on capital is a vital factor to be taken into consideration when deciding the amount to be charged to profit and loss and included in costs. In all cases where capital has been raised for the specific purpose of acquiring and operating complete layouts of chemical plant, adequate provision should be made for interest on the sum expended; failure to do this may have serious consequences by reason of incorrect or misleading costing. By adopting what is known as the 'annuity' method of determining and recording plant depreciation, a definite rate per cent. can be added to the opening balance of the asset account each year, and thereby increasing, for the time being, the total amount of unrecovered investment shown in the user's books but enabling the aggregate cost to be spread over a definite period in the form of equal annual instalments.

Provision for replacement of fixed assets

It is the recognised practice of many companies carrying on business as public utility undertakings to follow the practice of some companies incorporated under special Acts of Parliament and provide for the replacement of their fixed assets either by the establishment of renewal reserves against which is charged the cost of replacing plant, or by debiting the cost of replacement direct to revenue.

There is no uniformity in the method of showing fixed assets on balance sheets, although the initial cost of installing plant is often shown on balance sheets, the total sum provided or written off for depreciation to date being deducted to arrive at the current value. This is not always practicable in the case of firms acquiring existing businesses for a lump sum or where detailed inventories or other records are not available to enable the figures to be stated separately.

Depreciation and maintenance

The highest value that can be placed on groups of chemical plant consists of the first capital cost of acquisition and installation, including the invoiced prices of accessories, gadgets, etc., and any transport or foundation expenses, while the lowest value will be the value of the material and parts, after allowing for the cost of dismantling; consequently, many engineers base their calculations of the sum to be charged under the heading of depreciation of plant on the difference between these two extreme figures, with due regard to the particular circumstances and conditions under which the productive equipment is being operated. Methods of recording original capital expenditure are, therefore, of considerable importance, as a proper discrimination between capital and revenue items is essential.

Although plant which is properly handled and well looked after will usually last longer than that subjected to rough usage or neglect, modern process engineering operations tend to increase the danger of obsolescence. It is always advisable, therefore, to separate the charges for repairs and upkeep instead of showing these items in the same accounts as the charges for depreciation. To allow urgent repair work to get out of hand may prove very costly and, in the absence of factual information as to the performance, condition and running costs of specific units of profit-earning equipment, reliance would have to be placed on estimates, the accuracy of which may be difficult or impossible to verify.

Wear and tear allowances are, of course, subject to variation from time to time to satisfy the needs of industry, and to some extent they are likely to be governed by the degree to which the Inland Revenue authorities are assured that information of a basic nature—such as the performance of specific types of machinery, the use of particular installations and the average annual cost of maintenance—can be obtained from users. In this connection, the economic fulfilment of certain processes can often be facilitated by compiling annual and cumulative summaries of the cost of operating each unit of plant; by the systematic recording of all plant movements; and by keeping detailed records of all repair jobs, parts issued and plant histories, etc.

Forms or sheets used for the purpose of ascertaining the cost of the labour expended on each unit of plant should show the hours actually worked, with a separate section for office use and for arriving at the effective rate per hour. Such details can then be transferred to a plant repair labour abstract which will summarise the cost under each heading week by week and simplify the preparation of an annual summary showing the total cost and the nature and frequency of the repairs carried out.

Effect of new plant units

When new units of plant are

acquired, a special effort should be made to determine to what extent the effect of the acquisition will add to the existing stock under those headings. The amounts representing increases in the total value of the assets can then be treated as capital expenditure to be debited to the respective asset accounts, the charge against revenue taking the form of periodic deductions to cover wear and tear, obsolescence, effluxion of time and other deteriorating factors. When a machine is replaced by another machine of improved efficiency or utility the book value of the displaced unit should be written off and the net invoiced cost of the new asset debited to the appropriate private ledger account. If, however, it is desired to leave the balance of the asset account unchanged, the cost of replacement may be treated as expenditure against revenue by debiting the amount to the nominal ledger account, but in cases where a displaced unit of plant is sold at its estimated value the sum realised should be posted from the receipts side of the cash book to the credit side of the asset account before transfer to the final account.

Scientific approach to cost calculations

In the chemical and allied industries a large amount of capital has been invested in chemical plant of one kind or another and in the compilation and allocation of processing costs and the periodical assessment of asset values users should not be so much influenced by the scale of depreciation allowances granted by the Inland Revenue as by the ultimate service or useful life of the different types of equipment. It is true that depreciation computations are sometimes complicated by reason of wide variations in the estimated service life of capital additions, but the nature of the loss does not change and, instead of providing lump sums to cover depreciation or reducing the book value of plant in a variable manner, the amounts to be written off each year should be determined in accordance with definite principles and incorporated in the costs.

During recent years a good deal of work has been done on the scientific side and in some industries a technique of control based on statistics has now been developed. This has proved to be of immense practical value and in some branches of process engineering a system of inspection-cum-production is now in operation.

(To be continued)

RECENT PUBLICATIONS

Hydro-electric generators. Increasing demand for electrical energy and the need to conserve coal and oil have led to increased exploitation of water power. At the same time, engineering progress has perfected hydraulic plant and electrical equipment with higher efficiencies and, more especially, lower capital costs as a result of new forms of construction. During the past 60 years particular attention has been paid to this field by A.E.G. (Allgemeine Elektricitats Gesellschaft), of Germany, and an excellent survey of their work in this field is provided by a brochure illustrated with transparent sectional drawings, showing the various constructional features of the horizontal-shaft A.E.G. generator. This is preceded by an explanatory description. For anyone wanting to know the 'ins and outs' of this type of equipment, this publication should prove very useful.

Nickel. The first issue of a new publication, to be issued periodically to all interested in nickel and its by-products, appeared recently. Produced by the Mond Nickel Co. Ltd., it includes illustrated articles and notes on many subjects and in future issues there are to be articles on uses of nickel, copper, cobalt, gold, silver, the platinum metals, selenium, tellurium, sulphur and iron ore.

Corrosion in brewing and allied industries. A broadsheet devoted to corrosion problems in the brewing, distilling, malting, cider-making, soft drinks and related industries is published regularly by Corrosion Ltd. A recent number gives information on BCL cask lacquer, relining cold-room tanks *in situ*, stripping epoxy-based paints, linings for steep cisterns, etc.

Rotary louvre dryers, coolers, etc. A new illustrated brochure pros duced by Dunford & Elliott Proces-Engineering Ltd. describes the scope and use of rotary louvre installations and illustrates their operating principles and mechanical construction.

Catalysts for industry. Cobalt and molybdenum oxides on alumina catalyst and other metals with alumina base are described in a leaflet from Peter Spence & Sons Ltd. These are use by petroleum refineries for the desulphurisation of petroleum products and the refining of benzole. The same company have also issued a leaflet on their chromatographic alumina.

Gas condensing and cooling. Publication No. 60 from W. C. Holmes & Co. Ltd. describes and illustrates procedure in condensing and washing gas and also the problems to be met in designing apparatus for such operations.

Valves, controllers, desuperheaters, etc. A 20-page illustrated booklet has been issued by British Arca Regulators Ltd. giving details of their wide range of apparatus.

Gas-washing equipment. A leaflet from the Kestner Co. Ltd. gives details of a self-contained unit for producing intimate contact between gases and liquids for use in gas washing, acid fume and dust removal, suppression of objectional odours and for a wide range of chemical and manufacturing processes.

Accident prevention. In connection with National Industrial Safety Week, from November 5 to 10 this year, the Industrial Safety Division of the Royal Society for Prevention of Accidents has issued a leaflet describing some of the more common causes of accidents and aimed at making workers and managements more aware of the dangers of careless work methods.

Non-destructive testing of engineering materials. In a 32-page publication from A. E. Cawkell, two instruments are described for measuring non-destructively certain properties of engineering materials. The first is used to measure the time of propagation of a pulse of longitudinal vibrations of ultrasonic frequency through the specimen. The second is used to measure the resonant frequency of the specimen by mechanically connecting it to a vibrator, and the frequency is varied until resonance is reached.

Waxes, oils and greases. The chemical structure, specifications, properties, applications and general description of a new group of fluorocarbon oils, waxes and greases for industrial use are described in a new 16-page booklet distributed by the M. W. Kellogg Co., U.S. It is pointed out that corrosion, temperatures and pressures in many industries have exceeded the limits of even the most rugged lubricants, sealants and fluids; the development by Kellogg of a series of polymer products based on the extremely stable polychlorotrifluoroethylene molecule is claimed to offer an answer to many problems. Among the applications suggested in this booklet are hydraulic pumps, pump fluids, potting and sealing waxes, etc.

★ Personal Paragraphs ★

★ **Dr. A. W. Pearce,** assistant refinery manager at the Esso refinery, Fawley, since April 1954, has been appointed to fill the newly created post of general manager of refining at the company's head office in London. In his new capacity he will be responsible for co-ordinating all the refining and manufacturing activities of the company in the United Kingdom. He graduated in chemical engineering from Birmingham University in 1945, and joined the company that year as technical assistant at the old Fawley refinery. As assistant manager, technical service department, in 1947 he was closely concerned with the design and construction of the new refinery and, in 1950, he was appointed process superintendent and was responsible for training all operating personnel for the new refinery. He was also in charge of the start-up of all new refinery equipment from the time the new refinery came on stream in 1951 till his appointment as assistant refinery manager in 1954.

★ The Carbon Dioxide Co. (a division of the Distillers Co. Ltd.) has announced the appointment of **Mr. S. C. Stewart** as director in charge of the division. He has been a division director of the Carbon Dioxide Co. for some years, and is general manager of the Industrial Alcohol Division and a division director of the British Industrial Solvents Division of D.C.L.

★ **Sir Peter Roberts,** BT., M.P., who is to be the next Master Cutler, is chairman of Newton Chambers & Co. Ltd., Thorncliffe, near Sheffield, and also chairman of Wellman Smith Owen Engineering Corporation Ltd., Darlaston, Staffs., in which company Newton Chambers have a large interest. His family has been associated with industry in the Sheffield district for more than 300 years and he is a direct descendant of Robert Sorsby, first Master of the Company of Cutlers in Hallamshire created by special Act of Parliament in 1624. He became chairman of Newton Chambers in succession to his father, the late Sir Samuel Roberts, BT., in December 1954. The business was established in 1793.

★ **Mr. W. M. Thompson,** sales director of Monsanto Chemicals Ltd., has been appointed a director of Monsanto Plastics Ltd., a wholly owned subsidiary of the former company.

★ **Mr. J. J. Powers, Jun.,** president and chairman of the international chemical and pharmaceutical manufacturers, Pfizer International, New York, has announced, on the occasion of a visit to the firm's British subsidiary, Pfizer Ltd., Folkestone, important developments in the British company's organisation. **Mr. R. C. Fenton,** vice-president and director of Pfizer International, has been appointed area manager for all Pfizer undertakings in northern Europe and Africa. Simultaneously, he has been elected first chairman and managing director of Pfizer Ltd. **Mr. J. Rodgers,** a fellow director of Pfizer Ltd., remains this company's general manager. **Mr. P. V. Colebrook,** works and production manager of the company's plants at Sandwich and Folkestone, has been elected a new member of the board. The fourth director of Pfizer Ltd. is **Mr. J. M. Wallace,** formerly a vice-president of the Chase Manhattan Bank. All four directors of Pfizer Ltd. are British.

Dr. A. W. Pearce

★ **Lord Reith** has been appointed a director of the British Oxygen Co. Ltd.

★ The appointment of **Mr. R. Wilson** as divisional managing director of British Electro Metallurgical Co. has been announced.

★ All research activities in the Industrial Chemicals Division of Olin Mathieson Chemical Corporation have been combined under the direction of **Dr. B. H. Wojcik,** who has been named manager of research and development for the Industrial Chemicals Division.

★ **Mr. A. R. Loosli** has been appointed general manager of the newly formed Fibres Division of American Cyanamid Co. He has been with Cyanamid since 1937 and held numerous posts in the Organic Chemicals Division before his appointment, in 1954, as assistant general manager, Fine Chemicals Division. Immediately prior to his new appointment he was assistant general manager of the company's Industrial Chemicals Division.

Mr. P. V. Colebrook

★ **Dr. G. B. B. M. Sutherland,** F.R.S., took up his appointment as Director of the National Physical Laboratory on September 14.

★ **Dr. J. Pearson,** assistant director of the British Iron and Steel Research Association, has recently taken over charge of the Sheffield laboratories. He retains the headship of the Steelmaking Division, but will relinquish control of the chemistry department, for which **Mr. E. W. Voice,** head of the Ironmaking Division, will become responsible. **Mr. R. Mayorcas** will be appointed deputy head of the Steelmaking Division.

★ **Mr. L. A. Wiseman** has been appointed deputy director of the British Rayon Research Association, and will join the staff on December 1. He is 40. He is at present working at the Atomic Weapons Research Establishment at Aldermaston.

★ **Dr. H. W. Melville,** F.R.S., took up his appointment as Secretary of the Department of Scientific and Industrial Research on August 27.

World News

NEW ZEALAND

New Zealand urged to establish carbide industry

New Zealand could profitably establish an expanding calcium carbide industry to supply the home market and export to Australia, according to Dr. T. Hagyard, senior lecturer in chemical engineering at Canterbury University College.

Speaking to a mining and quarrying conference in Dunedin recently, he said that research had led him to believe that the South Island had all the requirements for the setting up of such an industry. The west coast would be particularly suitable for the industry, according to other scientists at the conference.

Canada, the United States, Germany, France and other countries had all established profitable industries based on carbide production, Dr. Hagyard said. All but Germany based their calcium carbide industries on cheap and abundant electric power. In this respect, the potential of the South Island was considerable.

He said an annual production of 10,000 tons would be a desirable target. Australia was manufacturing only two-thirds of her annual carbide requirements of 30,000 tons, while New Zealand imported 1,700 tons a year, he added.

VENEZUELA

Petrochemical projects

A new autonomous institute—the Venezuelan Petrochemical Institute—is a dependency of the Ministry of Mines and Hydrocarbons and, in addition to the petrochemical project, is responsible for the national gas pipeline network which is to run eventually from Anaco in the east *via* Caracas, Valencia and Moron as far as Barquisimeto in the west, and for the Government-owned coal (Naricual), gold (El Callao), pyrites, phosphate and gypsum mines.

The capacity (metric tons) of the petrochemical plant now under construction at Moron, near Puerto Cabello, had been modified as follows: chemical fertilisers (this unit should begin operating late this year), 150,000; chlorine, 10,000; caustic soda, 11,200; and dynamite, 10,000.

Later development will comprise: an insecticide, fungicide and herbicide plant; other types of explosives; synthetic rubber; a miscellaneous by-products plant producing plastics, lacquers, etc.; and a 3,000-barrel/day oil refinery as an auxiliary to the main petrochemical plant which will be used chiefly to extract products required for the other operations.

AUSTRALIA

Sulphuric acid plant

The refining of uranium ore from Rum Jungle in Australia's Northern Territory will be stepped up by a new sulphuric acid plant now under construction. The new plant is being built by Simon-Carves (Australia) Pty. Ltd. for Territory Enterprises on behalf of the Federal Government.

The plant is expected to more than treble the present acid-producing capacity at Rum Jungle. Machinery for the plant is being shipped from England, and structural steel and other equipment is being taken some 2,000 miles by road from Sydney.

INDIA

Acetic acid import quota raised

The Indian Government has announced an increase in the quota for the import of acetic acid from dollar as well as soft-currency areas. The increase is from 25 to 37½% for the current half-year.

Antibiotics production

The factory of Hindustan Antibiotics, Pimpri, has exceeded the first Five-Year Plan target of the production of 4.8 million mega units. By the end of March 1956 actual production had reached 6.4 million mega units. The capacity of the plant is to be expanded by 60% at an approximate cost of Rs. 42 lakhs. Work on this scheme is expected to take two years, by which time the capacity of the plant will rise to 25 million mega units/yr. The Government has already announced its decision to produce streptomycin and bicillin at Pimpri.

Heavy water plant

It has been decided to locate the Nangal fertiliser and heavy water factory on the right or western bank of the Sutlej, opposite Nangal township. The annual production capacity of the Nangal factory is expected to be a minimum of 70,000 tons of fixed nitrogen and 14 tons of heavy water. The factory is one of the three new fertiliser projects included in the second plan.

NORWAY

Nitro cellulose plant

A new plant for the production of nitro cellulose has begun operations in Hurum, near Oslo. The plant is an extension of a factory owned by the Nitroglyserin Compagni, sole producers of nitro cellulose in Norway. Covering an area of 1,000 sq. m., it cost 5.5 million crowns and took two years to build. It will considerably increase the firm's annual output of nitro cellulose. The Nitroglyserin Compagni makes nitro cellulose for three main uses—for dynamite, for gunpowder and for cellulose for paints and varnishes.

Increase in ores and metals export

In the first six months this year, the value of Norwegian exports of ores and metals increased by 44% compared with the same period last year. The value of ores and metals sold abroad from January to June was £36,150,000, including iron and steel to a value of £9,450,000 and aluminium to a value of £7,750,000.

Ores and metals now rank first in importance among Norwegian exports, having ousted pulp and paper, which until this year constituted Norway's principal export. The value of Norwegian paper and pulp exports up to the end of June was £27½ million, compared with £25 million in the first half of last year.

COLOMBIA

Paper factories

The Container Corporation of Canada and Cartones Colombia will build a paper and pulp factory based on the extensive forest reserves on the Carare River 150 miles north of Bogota. The factory, to be set up with a capital of 20 million pesos, will be called Empresa Colombiana de Papel.

Though the pulp will mainly be used for cardboard and commercial papers, it is expected that it can also be bleached for use as newsprint.

Empresa Nacionalde Publicaciones is to build its own newsprint factory to start production towards the end of next year. The daily capacity will be 100 tons—more than Colombia imports at present. The latest figure announced for imports of newsprint was 19,000 tons in 1954, of which 15,000 tons came from Canada.

U.S. company starts operations

The Reynolds Metals Co. has begun operations at an aluminium rolling mill and fabricating plant in Barranquilla, Colombia, which will produce

300,000 to 400,000 lb. of aluminium products monthly.

The plant is being run by Aluminio de Colombia-Reynolds International Incorporated (wholly owned Reynolds metals subsidiary for foreign manufacturing enterprises) and Colombian interests.

The plant and lead factory attached to it were purchased recently from the Compania Argentina Metalurgica Estano Aluminio S.A., in Buenos Aires.

GERMANY

Progress of iron and steel concern

The A.G. für Berg und Huttenbetriebe, the state-owned iron-ore and steel works complex at Salzgitter in Lower Saxony (formerly the Reichewerke) achieved a 33% increase in turnover last year (to September 30, 1955) to a total of D.M. 1,500 million with only a fractional increase in its labour force of about 60,000.

In the past eight years nearly D.M. 900 million has been invested in plant and equipment including D.M. 222 million in the latest year. Crude steel capacity amounts to 1.5 million tons/yr. and iron-ore production to about 6 million tons. Recently discovered deposits of iron ore in adjacent areas indicate a new potential source of ore amounting annually to about 20 million.

Plastics

The German 'Mannesmannwerke' propose to build a factory at Wiltz for the manufacture of plastic tubes and pipes. The factory is being erected on the site of a tannery which was closed recently.

SOUTH VIETNAM

Paper factory

A new company bearing the style Societe des Papeteries Vietnamiennes was formed early in June with the object of undertaking the local manufacture of paper. The firm's capital is to be 30 million piastres, of which 8 million has already been paid up by the founder members.

The project envisages the use of local pines, bamboo and straw as raw materials. Chemicals will have to be imported in the early stages, but, if plans for the construction of a hydro-electric station at Danhim near the proposed site of the paper factory come to fruition, it is hoped to produce soda and a substitute for chloride of lime from sea water (the coast is some 80 miles away) by electrolytical processes. Water for the factory itself will be readily available from the River Danhim.

HUNGARY

New £12-million factory

Work has recently begun on a new £12-million straw cellulose factory at Sztálinváros which will manufacture sulphite cellulose from rice straw and is scheduled to begin production at the end of 1958.

About 200 tons of straw will be processed daily—more than 64,000 tons/p.a. Factory equipment is to be imported from Finland and the East German Republic, though some Hungarian-made machinery will also be used.

When in full production the factory will produce 44% of the straw cellulose—today mostly imported—used by the paper industry. This, it is estimated, will save about $2 million a year in imports.

The factory has been built near the River Danube so that the great quantity of water needed can be cheaply obtained. Steam will be supplied by the nearby iron and steel works—part of the great Sztálinváros industrial complex.

SWITZERLAND

New pharmaceutical plant

Under its 80-million Swiss francs investment programme Ciba A.G., of Basle, is building a pharmaceutical processing and packaging works at Stain in the Aargau Kanton. The plant, which will be equipped with conveyor belts and will employ 500 workers, is nearing completion.

Production of chemicals

The annual report for 1955 of Lonza S.A. lays particular stress on intensified international competition in chemicals. Sales of Lonza's organic products on the home market were good, though sales prices were under heavy pressure. Exports rose. Demand for nitrogen products for fertilisers and for technical purposes remained at the same level as in 1955. Prices for these products are below the average of Lonza's foreign competitors. Thanks to the introduction of new products the firm's Swiss factories showed an increase in total turnover as compared with 1954.

EGYPT

Fertiliser imports discussed

The Egyptian Minister of Commerce, Dr. Mohammed Abu Nosseir, has conferred with a trade mission from East Germany, led by the Deputy Foreign Trade Minister, Mr. Heinrich Rau, on the importing of 90,000 tons of chemical fertiliser from East Germany in exchange for Egyptian cotton and other agricultural products.

FRANCE

First large germanium power rectifier in France

Recently the first large germanium power rectifier equipment to be installed on the Continent of Europe (not including the U.K.) was put into service at Pechiney's St. Jean-de-Maurienne factory, Savoy.

The equipment was made by British Thomson-Houston and consists of two 1,000-kw., 250-v., 4,000-amp., fan-cooled germanium power rectifiers.

Working in parallel with existing motor converters the B.T.H. rectifier equipment will provide the d.c. supply to a series of electrolytic cells for the production of aluminium at the St. Jean-de-Maurienne works.

Polythene projects

It is reported that two new factories are to be built at or near Gonfreville,

COMPANY NEWS

The U.K. associates of the International Honeywell organisation have opened a branch office in Belfast. This offers assistance with the choice, installation and maintenance of the company's industrial instrumentation, precision snap action switches, and automatic controls for heating and air-conditioning systems.

★

Hess Products Ltd. and A. Hess & Bro. Ltd., of Leeds, manufacturers of *Distec* fatty acids and wool grease stearines and oleines, have opened a Birmingham office at 191 Corporation Street (telephone: Central 3891).

★

Teddington Aircraft Controls' recently-formed Industrial Bellows section will now be based at Ammanford, where their factory is in full production. Teddington are producing stainless-steel bellows with a wide variety of applications in the chemical, diesel, steam plant, petrol-refining, atomic energy and marine industries.

★

The Badger Manufacturing Co., of Cambridge, Massachusetts, and Comprino N.V., Amsterdam, are forming a jointly-owned subsidiary, Badger-Comprino N.V., with headquarters at The Hague. The new firm will furnish engineering, procurement and construction services for petroleum-refining and chemical industries.

near Le Havre, for the production of polythene. France's present consumption of this plastic is 7,000 tons p.a., compared with home production of 4,000 tons.

AUSTRIA

New lubricating-oil installation

The most modern grease unit in Europe forms part of a new lubricating-oil-blending installation which has recently come into service at Wien-Simmering.

Planned by Shell in 1950, these facilities will add materially to the domestic output of high-grade products, which previously had to be imported to meet increasing industrial demand. The combination of the new units and the refinery at Floridsdorf will enable Shell Austria A.G. to manufacture some 225 products representing 75% of the total it requires for home markets. Indigenous raw material will be used almost exclusively.

The installation consists principally of three main plants for grease manufacture, oil blending, and the manufacture of products from mineral oils and chemical raw materials.

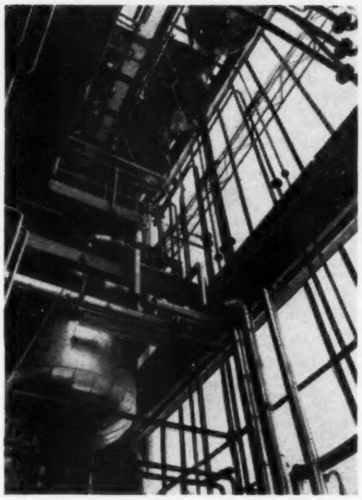
Modern units for grease making enable all stages of manufacture to be closely controlled. At Wien-Simmering, high-performance greases are being made, including multi-purpose greases for automotive and industrial uses. The luboil blending plant will serve Vienna and the eastern part of the country, where distribution of these products has recommenced since the Austrian State Treaty. The third plant will prepare metal-working oils and oils and fibre lubricants for the textile industry as well as agricultural and horticultural products.

In addition to the three main plants, there are storage tanks, railway sidings, a boiler house, a transformer station, an administrative building with a laboratory, and a building for the staff with canteen and changing rooms. The plant was erected on a plot of 12 to 13 acres. In the course of the construction, over 12 miles of pipelines had to be laid. Sixty pumps are used for conveying the various products from storage to blending vessels and from plants to storage.

DENMARK

Atomic energy

The head of the Atomic Energy Research Centre at Riso, Prof. T. Bjerge, recently signed a contract with an American firm for the construction of the first Danish research reactor. The U.S. Government have granted $350,000 to help finance the project.



View of the grease plant of the Wien-Simmering lubricating-oil installation in Austria, mentioned on this page.

The reactor is expected to be installed in the first half of 1957. An agreement was concluded with the U.S. Government to increase the supply of uranium to Denmark from 6 to 12 kilos. The uranium will be 20% enriched. The agreement, which is a supplement to the one concluded in June 1955, also permits Denmark to buy or hire small quantities of uranium 233, uranium 235 and plutonium, for research purposes.

Ore from Greenland

The whole of the first year's production of lead ore from the Mestersvig mines, now said to be about 7,000 tons, has been sold to Belgium. Next year's production is expected to reach about 18,000 tons. The search for uranium in South Greenland was resumed. Samples of rock analysed have shown the possibility of the presence of both uranium and thorium.

Oil consumption increases

Trade circles announced that Denmark's consumption of mineral oil products in 1955 amounted to 2,978,000 tons, an increase of 26% on the previous year.

BRAZIL

Plans for chemical factories

A consortium of three large concerns of Swiss chemical manufacturers, Sandoz, Ciba and Geigy, is to build a factory next year at Rezende in the state of Rio de Janeiro. Production is expected to begin in 1959.

The American pharmaceutical firm, Lederle Laboratories, is also to build a factory at Rezende.

GREAT BRITAIN

Scottish chemical engineering courses

The Royal Technical College, Glasgow, is offering this year a four-year degree course in chemical engineering. The college is also offering an associateship course of four years covering the same main subject groups. A four-year course in chemistry for the associateship is also available and a four years' course has also been offered in technical chemistry, for the applied chemistry degree and technical chemistry associateship courses.

The Heriot-Watt College, Edinburgh, is providing courses for associateship in chemical engineering or B.Sc., Technological of Edinburgh University, with which the college co-operates.

Posters for industry

An interesting application of art to industry has been demonstrated at Ardeer, where I.C.I. are using colour posters showing enlarged details of certain operations in fusehead assembly work. These pictorial displays supplement the formal working regulations, and illustrate faults to be avoided and the correct procedures—all presented in a simple and effective manner. Decision to use 'visual aid' techniques was taken by the Nobel Division management some time ago.

UNITED STATES

Extensions to synthetic rubber plant

Extensions costing several million dollars are being made to the Shell Chemical Corporation's synthetic rubber plant at Torrance, California. Shell purchased this complex from the U.S. Government only last year and immediately started a modernisation programme designed to meet the growing and changing demands for synthetic rubber. It is the only plant of its type west of the Rockies and is now the main supplier there of synthetic rubber for car tyres, floor coverings and other rubber goods.

A new unit, to be finished this autumn, is being built to produce special synthetic latex for foam-rubber goods. The copolymer plant for the manufacture of synthetic rubber is being enlarged and its capacity raised from 89,000 to 110,000 tons/p.a. of a wider range of rubber types.

In addition, the butadiene unit at Torrance is being extended in order to provide the increased quantities of this essential raw material for the production of synthetic rubber.

Besides its additions to the manufacturing plant, the company is also building a new research laboratory and pilot plant which will enable Shell Chemical Corporation to expand its already considerable research effort in the field of synthetic rubber.

Coal-cleaning method

Use of the dense-medium process to salvage coal from waste materials may save thousands of dollars annually for the coal industry, according to the U.S. Bureau of Mines. The technique uses a suspension of fine particles of magnetite or other heavy solids in water to separate valuable bits of coal from dirt, rock and shale. Heavy wastes sink to the bottom of a separating bath while the lighter pieces of coal float to the surface.

The dense-medium process has been used for several years to clean raw coal as it comes from mines.

Hydraulic metal powder compacting press

An advance in the field of powder metallurgy is expected to result from a new 300-ton, hydraulically operated metal powder compacting press developed by the Baldwin-Lima-Hamilton Corporation. It will enable manufacturers to produce, for the first time without additional tooling, such shapes as a double counterbore (a counterbore in each end of the part) and a double hub (a hub on both sides of the flange). Variation of these shapes is possible.

Chemical firm announces price increases

The Solvay Process Division of the Allied Chemical & Dye Corporation recently announced price increases averaging 50 cents/100 lb., in carload lots, on ammonium bicarbonate, ammonium chloride and sodium nitrate.

This was regarded by some trade circles as possibly indicating a general move by the industry to reflect higher costs—in both wages and materials—in prices of a number of 'heavy' basic chemicals, profit margins of which are regarded as insufficient.

Export decree on selenous acid

Selenous acid has been added to the positive list of commodities requiring individual export licences for shipment to all destinations except Canada, the Bureau of Foreign Commerce of the U.S. Department of Commerce has announced in Washington. Selenous acid, a compound of selenium, is in short supply.

The Leonard Hill Technical Group—October

Articles appearing in some of our associate journals this month include:

Manufacturing Chemist—Planning and Controlling Research in a Pharmaceutical Company; Health and Hygiene in the Fine Chemicals Industry; A Critical Survey of Automatic Titrators, 2; Application of Chelating Agents; Preparation and Distribution of Radiochemicals; Progress Reports.

Food Manufacture—Automatic Control in a Biscuit Factory; Smoke-curing of Salmon and Trout; Trace Elements, 3: Selenium; East Africa's First Margarine Plant; Plant Proteins and Vitamin B_{12}; Fruit, Vegetables and F.I.O.; Survey of the Food Fair.

Paint Manufacture — Automatic Control in the Paint Industry; Instrumentation for the Factory; Paints without Odour.

Petroleum—Trends in Lubricating Oil Requirements; Infra-Red Absorption Analysis in the Petroleum Refinery; Plant Calculations for the Petroleum Technologist: Water Cooling, 4; Recent Advances in Oil Geology, 5.

Corrosion Technology — Nickel Plating by Chemical Reduction; Reduction of Corrosion in Ships' Cargo Tanks by Dehumidification; Hydrogen Blistering at a Fluid Catalytic Cracking Unit; Organic Corrosion with Special Reference to Synthetic Plastic Materials.

Building Materials—Fire Tests of Gypsum Roofing; Oil-Burning Appliances; Concreting in Cold Weather; Townships on the Move.

Floors—Chemical-Resisting Industrial Flooring.

World Crops—Managing Irrigated Soils; Tea Soils and Their Management; Cure and Prevention of Virus Diseases in Plants; Solar Energy, 2: Solar Power Units and the Future; Biological Control of the Prickly Pear.

Dairy Engineering—Mechanical Causes of Sub-Normal Milk; Plastic Road Tankers for Milk Transport; Cooling of Milk at the Production Point; Process Steam in the Dairy Industry; Oil as a Fuel; Oil-Fired Boilers; Packaged Boilers; A New Heat Exchange Installation for Nottingham Co-op.

Fibres—Air Treatment for Textile Manufacture; Monoecious Hemp Breeding in the United States; Studies into the Shock Loading of Textile Yarns.

Automation Progress—Automation of Laboratory Analytical Procedures; Materials Handling for Automation; Plug-in Digital Computers; Electronic Control of Machine Tools; The Fully Automatic Plant; Air Gauging Aids Automatic Production; In-Line Transfer Machines; Automation in the Office.

Muck Shifter—Building a Road Embankment Across a Bay; Mile-Long Bridge with 14 Spans of 397 Feet; Tunnel Constructed by Dropping Steel Tube in Under-Water Trench.

Showing up flow lines of moving liquids

The flow diagrams of liquids flowing round obstacles of different kinds and shapes can be determined only with difficulty when these streams are turbulent, as is the case in the majority of industrial uses. Laboratory tests therefore generally record data only for slow, evenly flowing streams which give only an approximate picture of the actual conditions prevailing in industrial streams. The inaccuracy of this method has a harmful influence in the case of turbines and hydraulic pumps, for example, both on the design of the blade contours and the precise determination of the liquid velocity at different points of the section being examined.

This drawback can be eliminated by using an outstandingly simple apparatus built at the Machinery Institute of the University of Padua, and described by G. Gottardelli in *La Ricerca Scientifica*, 1954, **24** (3), 585. This apparatus plots the diagram of the flow lines of the stream around an obstacle having a given contour by means of tiny air bubbles entrained by the moving liquid which are visible from a glass plate which closes the top of the apparatus. The air bubbles are sucked through special holes into the liquid and their lower specific weight keeps them on the surface.

With a known flow of liquid and distance between the air suction holes it is possible to determine the water flow between two adjacent streams and, by measuring on the glass plate the distance between these two streams, the velocity of the liquid at every point considered can be determined.

The test unit consists of a closed circuit comprising a tank, a feed pump and the test apparatus. A rotary pump driven by an asynchronous motor sucks water from the tank, through a large-diameter pipe on which the test apparatus is mounted by means of an inlet and an outlet connection. The pump discharges the aspirated water into the tank. The test apparatus consists of a small cabinet measuring about 200 $\times$ 100 $\times$ 6.5 mm., painted white inside and closed on top by a glass plate, into which the obstacle (blade cross-section, etc.) is placed. The water enters through one of the smaller sides of the cabinet and goes out on the opposite side, sucked through a system of directional vanes.

Upstream of the glass plate there is a wooden cross-bar carrying several

½-mm.-diam. holes 1 cm. apart. Since the pipe on which the apparatus is mounted is under suction, air bubbles are sucked through these small holes and, entrained by the water, adhere to the glass because of their smaller specific weight and make visible the motion of the water, faithfully following the flow lines around the obstacle. To eliminate all possibility of the bubbles deviating cross-wise, the cabinet must be perfectly horizontal. The flow lines can also be recorded photographically, exposing the negative a reasonably long time.—*E.P.A. Digest No.* 659.

European Convention of Chemical Engineering, 1958, Frankfurt am Main

Preparatory work in connection with the European Convention of Chemical Engineering, which is to be held in Frankfurt am Main during the period May 31 to June 8, 1958, in connection with the Achema 1958 Twelfth Chemical Apparatus and Equipment Congress and Exhibition, has been proceeding.

The 23 European technical and scientific societies which together form the European Federation of Chemical Engineering will also hold their second congress within the framework of the European Convention of Chemical Engineering. This congress will open in Brussels (May 28-30, 1958) and will continue in Frankfurt am Main (May 31 to June 8, 1958). The European Federation of Corrosion, to which some 45 European technical and scientific societies belong, is also planning to hold its second congress in Frankfurt am Main. Furthermore, the Gesellschaft Deutscher Chemiker (Society of German Chemists) will hold a special meeting, and the Dechema (Deutsche Gesellschaft für chemisches Apparatewesen e.V.) will hold their 33rd annual general meeting during the course of the European Convention of Chemical Engineering. Finally the Dechema will conduct an international Achema students' meeting, to which all advanced students of chemistry, physics and engineering as applied chemical apparatus and equipment and process engineering will be invited. There is also every possibility that meetings and congresses of other technical and scientific societies will be organised and conducted in connection with the European Convention of Chemical Engineering.

There will be 13 large exhibition halls, having a total floor space of 66,000 sq. m., at the disposal of the Achema 1958 Chemical Apparatus and Equipment Congress and Exhibition.

British Patent Claims

Dispersions of carbon black

An aqueous dispersion of C black of *p*H 7 to 12, containing as dispersant a water-soluble salt from a homogeneous copolymer of maleic anhydride and a C_{5-10} olefinically unsaturated hydrocarbon, said copolymer having a mol weight $<5{,}000$ and a viscosity (of a 35% solution in an inert organic solvent) $<1{,}000$ centipoises at 25°.—752,205, *Rohm & Haas Co. (U.S.)*.

Regeneration of ion-exchangers

Ion-exchange material is regenerated by passing an acid or a base (as appropriate) though the material and electrolysing the effluent regenerant in a cell with $\nless 2$ compartments separated by an ion-exchange diaphragm(s) to produce the acid and base of the salt, one of which (or both) are used for further regeneration.—751,855, *Permutit Co. Ltd.*

Recovery of acids from effluents

An acid is recovered from an aqueous effluent from a manufacturing process, *e.g.* chromium plating, for re-use in that process, by passing the effluent through an anion-exchange material, removing these anions in salt form on regeneration of the resin and recovering the acid by hydrolysis of the salt.—751,856, *Permutit Co. Ltd.*

Electrostatic precipitators

A precipitator for the removal of dust from gases has collecting electrodes each composed of a row of electrode elements, each element being of a width not exceeding 4 in. The elements are rigidly secured to a support member at their upper ends, and their lower ends rest against spacers fixed to a rapper bar, which consists of two flats with the spacers fixed between them. Rapping may thus be efficiently applied without adverse effect to the precipitator structure or to the electrodes.—747,301, *Simon-Carves Ltd.* et al.

Arc for chemical reactions

Cracking or chemical synthesis is effected by the use of two mutually insulated coaxial conical electrodes, the base of one having sonic or supersonic vibration generating means secured to it, and with a pile of imperfectly contacting annular metal elements at its apex, the other electrode having a magnetisable ring radially opposite the pile of elements.—751,735, *A. Bagnulo (Italy)*.

The above are abstracts reproduced from the weekly Patents Abstracts Journal *by permission of the Technical Information Co. The complete specifications can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, price 3s. each.*

MEETINGS

Incorporated Plant Engineers

October 9. 'Industrial Drying,' by R. R. Clegg, 7.15 p.m., Engineer's Club, Albert Square, Manchester.

October 18. 'Steam for Process,' by L. G. Northcroft, 7.30 p.m., Golden Lion Hotel, Blackburn.

November 6. 'The Use of Radio Isotopes in Industry,' by C. W. Jones, 7 p.m., Royal Society of Arts, John Adam Street, Adelphi, Strand, London, W.C.1.

Chemical Society

October 5. 'Corrosion Fatigue,' by U. R. Evans, 6.30 p.m., Chemistry Lecture Theatre, The University, Manchester. Joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry.

October 12. 'Acetylene-Allene Chemistry,' by Prof. E. R. H. Jones, 4.30 p.m., Chemistry Department, The University, Birmingham. Joint meeting with Birmingham University Chemical Society.

October 16. 'Isotopes in Industry,' by Dr. H. Seligman, 5.15 p.m., Appleby Lecture Theatre, Science Laboratories, The University, Durham. Joint meeting with Durham Colleges Chemical Society.

November 27. 'Mechanism of Solid-state Reactions and the Structure of the Solid State,' by Prof. W. E. Garner, 4.45 p.m., Lecture Theatre, Chemistry Department, The University, Nottingham. Joint meeting with Nottingham University Chemical Society.

December 6. 'Corrosion Fatigue' and 'Stress Corrosion,' by T. D. Weaver and Dr. K. R. Wilson, 7 p.m., Chemistry Department, The University, Bristol. Joint meeting with the Royal Institute of Chemistry, the Institute of Metals, and the Corrosion and Chemical Engineering Groups of the Society of Chemical Industry.

Society of Instrument Technology

October 12. 'Instruments in the Chemical Industry,' by P. J. K. Wilson, 7 p.m., Regent House, St. Phillips Place, Colmore Row, Birmingham 3.

INDUSTRY REPORTS . . .

Rheinpreussen progress

At the annual general meeting of Rheinpreussen A.G. (Germany) it was revealed that the restriction of activity in the chemical field contrasted with a further expansion in the sector of alcohol production. Capacity was raised by rationalisation and additional machinery, and output during the year totalled approximately 9,000 tons. Further measures now being taken will raise annual capacity to approximately 12,000 tons. Plant for the manufacture of plastic resins will also be expanded.

Sulphuric acid project

A report to the stockholders of Shawinigan Chemicals Ltd. (Canada) revealed that development of the new plant site in Shawinigan East was proceeding and construction of the sulphuric acid plant and of the pump house was well advanced. The new carbide furnace at Shawinigan Falls was practically completed.

St. Maurice Chemicals Ltd. had a satisfactory half-year's business. Construction of the new plants of Shawinigan Resins Corporation at Trenton, Michigan, and of Hedon Chemicals Ltd. at Hull, England, is proceeding according to schedule and the plants are expected to be in operation before the end of this year.

Industrial plant in glass

'The birth of a baby' to Q.V.F. Ltd. is how Sir Graham Cunningham, chairman and managing director of the Triplex group of companies (Britain) describes the setting-up during the year of the German subsidiary, Q.V.F. Glastechnik GmbH., at Wiesbaden, in his annual report and balance sheet.

Q.V.F. Ltd., a member of the group, is now a little under three years old. The report states that the progress made is definitely indicative of a healthy and prosperous future. Q.V.F. has already become one of the major world distributors of industrial plant in glass and glass pipeline; the sales curve has continued to rise steadily and progressively.

Fertiliser production in Israel

The progress report of Fertilisers & Chemicals Ltd. (Israel) for the first half of this year states that the construction programme has essentially been completed and the emphasis of the company's activities has shifted to production. During the period covered by this report, January-June 1956, ammonia and ammonium sulphate plants commenced commercial production, thereby achieving the main target of the company's programme: to make the country self-sufficient in the supply of fertilisers. In addition, the dicalcium phosphate plant came into operation.

Apart from the superphosphate production, which has exceeded local requirements for some time, the company has, in the first half of this year, produced over 2,000 tons of potassium sulphate and over 8,000 tons of ammonium sulphate. Currency in excess of \$6 million would have been spent this year had the goods which are now being manufactured by the company been imported from abroad.

Carbon and chemical plant

A number of interesting and soundly based developments of their business have been under active consideration by Powell Duffryn Carbon Products, who continue to produce heat exchangers, etc. This was revealed in the statement made by Mr. Herbert Merrett, chairman of Powell Duffryn Ltd., in the report of the directors of the company.

Ion Exchange

(*Concluded from page* 348)

cycle (*i.e.* when iron first appears in the hydrochloric acid effluent) the acid feed is stopped, and the column regenerated by passing water into the column from the top. As the hydrochloric acid concentration in the column decreases, so the $FeCl_4^-$ ions sorbed on the resin are hydrolysed, and the iron is eluted as uncomplexed ferric chloride. About 3 to 4 bed volumes of water are sufficient to remove all the iron. The resin is then finally backwashed to remove finely divided solid impurities, although this latter procedure may not be necessary at every cycle, or with every type of plant. It was estimated[15] that the cost of removal of iron from 30% hydrochloric acid was 13.06 cents/ton of acid, of which over 90% was in resin amortisation, assuming a three-year resin life span.

Chromic acid from plating baths

An example of the recovery of otherwise waste materials is given in the process for the recovery of chromic acid from plating baths using cation exchange.[16] Most of the chromic acid solutions available for recovery are dilute (50 to 200 p.p.m.), being obtained by the washing of 'drag out' from freshly plated parts. Simple collection and concentration of these solutions is not satisfactory, due to the build up of impurities in the recovered material. These impurities (mainly Cr^{+++}, Fe^{++}, Zn^{++} and Cd^{++}) can be removed by passing these dilute solutions of chromic acid down a column of strongly acidic cation exchanger in the hydrogen form.

In such dilute solutions the sorption of multivalent cations will be strongly favoured over that of univalent ions such as hydrogen ions, so that multivalent ionic impurities will be removed. Subsequent evaporation of the purified solutions gives chromic acid of sufficient strength to be returned to the plating baths.

This method saves chromic acid, indirectly purifies the plating baths from cationic impurities, and solves a difficult problem of waste disposal. The chief point of care is that the chromic acid solutions be sufficiently dilute, otherwise the life of the resin is shortened by oxidation. The process is now widely used industrially and appears completely sound economically.

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